Calhoun: The NPS Institutional Archive

DSpace Repository

Theses and Dissertations 1. Thesis and Dissertation Collection, all items

1993

Problems associated with lead paint removal in the construction industry.

Bensinger, William H.

http://hdl.handle.net/10945/24218

Downloaded from NPS Archive: Calhoun

Calhoun is the Naval Postgraduate School's public access digital repository for research materials and institutional publications created by the NPS community. Calhoun is named for Professor of Mathematics Guy K. Calhoun, NPS's first appointed -- and published -- scholarly author.

Dudley Knox Library / Naval Postgraduate School
411 Dyer Road / 1 University Circle
Monterey, California USA 93943

http://www.nps.edu/library

PROBLEMS ASSOCIATED WITH LEAD PAINT REMOVAL IN THE CONSTRUCTION INDUSTRY

BY

WILLIAM H. BENSINGER

A REPORT PRESENTED TO THE GRADUATE COMMITTEE
OF THE DEPARTMENT OF CIVIL ENGINEERING IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF ENGINEERING

UNIVERSITY OF FLORIDA

SUMMER 1993

T260220

PROBLEMS ASSOCIATED WITH LEAD PAINT REMOVAL IN THE CONSTRUCTION INDUSTRY

BY

WILLIAM H. BENSINGER

A REPORT PRESENTED TO THE GRADUATE COMMITTEE
OF THE DEPARTMENT OF CIVIL ENGINEERING IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF ENGINEERING

UNIVERSITY OF FLORIDA

SUMMER 1993

TK6510
C39n5
c.1

TABLE OF CONTENTS

	Title	Page
	Introduction	
Chapter 1:	History and Background	1
Chapter 2:	Medical Concerns of Lead Poisoning	4
Chapter 3:	Lead Paint Removal Strategies	10
Chapter 4:	Methods of Lead Paint Removal	16
Chapter 5:	Occupational Safety and Health Administration Guidelines	32
Chapter 6:	Environmental Protection Agency	45
Chapter 7:	NAVFAC Guide Specifications	55
Chapter 8:	Other Concerns	58
Chapter 9:	Summary	61
Appendix A:	Computer Program for Determining Costs	
Appendix B:	29 CFR, Occupational Safety and Health Administration	
Appendix C:	Naval Facilities Engineering Command Guide Specification	

INTRODUCTION

This paper will investigate the need for special procedures required by Governmental regulations for the removal of lead paint. A historical background on lead paint and the associated health problems it has and can cause will be discussed in order to familiarize the reader with the grave circumstances of not correctly handling this form of hazardous waste.

Various techniques of paint removal will be discussed along with complete paint removal to total paint encapsulation. The paper will not select the best overall method, as this is user dependent. However, the paper will offer the user/owner a selection of methods, each described in detail with comparitive costs. It is up to the user/owner to select the appropriate method based on the future use of the structure and the money available for the project. The described methods in this paper will only assist in that selection.

Furthermore, it should be noted that this paper is done using current Environmental Protection Agency (EPA) and Florida Department of Environmental Regulation (FDER) regulations and guidelines. Any change in these two entity's policies will effect the procedures discussed and should therefore be considered during future use.

CHAPTER ONE

The use of lead base paint is wide spread throughout the United States. Although the utilization of lead in the production of house paints has been eliminated, it is still used for marine product paints and in the protection of steel from corrosion. Even though house paints currently do not contain lead paint, it can not be concluded that all housing projects will be free from lead paint contamination. Lead paint from housing is still the major cause of lead poisoning in children today, especially in the low income sections of our cities.[1]

The same lead paint that causes lead poisoning in children is also the cause of lead poisoning in adults, especially in the construction industry. There are four common means of exposure for the construction worker, they are:

1) Ingestion of lead paint particles
2) Inhalation of lead paint dust
3) Inhalation of lead from gases released during welding or similar processes
4) Contaminated drinking water

---

[1] "Hearings before the Subcommittee on Health and the Environment", One Hundred Second Congress, H.R. 2840, U.S. Government Printing Office, 1991, page 25

There are other obvious forms of lead poisoning, however they do not relate to the scope of this paper.[2]

It is interesting to note at this point that lead paint poisoning was diagnosed prior to the 1960's when it became almost epidemic in the inner cities. Discussions of lead poisoning due to the work and the environment have been noted as far back as the 1890's in Australia. The specific cause of the lead poisoning eluded researchers for approximately ten years until a link was established between ingestion of paint by children and lead poisoning.[3] Even though extensive research was performed, this link was ignored and viewed skeptically by the public and even the medical profession.

This lack of attention by the public and medical community could be attributed to many factors but the main factors were that it effected people in low income areas or the lead industry itself (where it was expected).[4] National interest did not occur until lead poisoning of children was tied to the Civil Rights movement of the 1960's. However, this interest focussed on children with little or no attention being given to the construction industry worker. Then, beginning with the early 1970's through passage of the

---

[2] Ibid, page 52

[3] Lin-Fu, Jane S.,"Children Today", U.S. Department of Health, Education and Welfare, Jan-Feb 1979, page 1

[4] Ibid, page 2

Occupational Safety and Health Act (OSHA), 29 U.S. Code, national attention began to place an interest in lead paint effects on the construction industry.

In comparing OSHA, EPA and FDER regulations the more specific of the three is OSHA. Both the EPA and FDER refer to general sections dealing with hazardous materials or gases. On the other hand, OSHA is very specific and safety guidelines for workers and the surrounding environment. Recently, the U.S. Navy, Naval Facilities Engineering Command has released very specific requirements for lead paint removal on its' structures. All these regulations are fairly recent and will be studied in depth later in this paper. The point to be made is that this sometimes fatal poisoning has been diagnosed for almost a decade with only recent legislation to combat its' affects.

CHAPTER 2

To understand the specific regulations effecting lead paint removal a comprehension of how lead poisons the human system is required. This portion of the paper will also highlight many of the symptoms of lead poisoning along with long range physical and mental handicaps that result from the lead poisoning.

As discussed in Chapter 1, the main cause of lead introduction to the human body is through some form of ingestion. This could be due to inhalation of particles, dust, gases or some other form of ingestion. Ingestion itself can occur in many ways:

1) Eating and swallowing of paint chips themselves
2) Paint dust contaminating food and water

From ingestion, the lead is then digested in the stomach and absorbed into the blood system. Once in the blood system, the lead initially has the highest accumulation in the liver and kidneys but eventually finds its' way to the brain and bones. Even though there are obvious affects on the first two organs mentioned, they can be treated successfully. However, absorption by the bone is long lasting and can cause relapses

of lead poising for decades.[5] Effects on the brain range from temporary headaches to debilitating permanent damage.

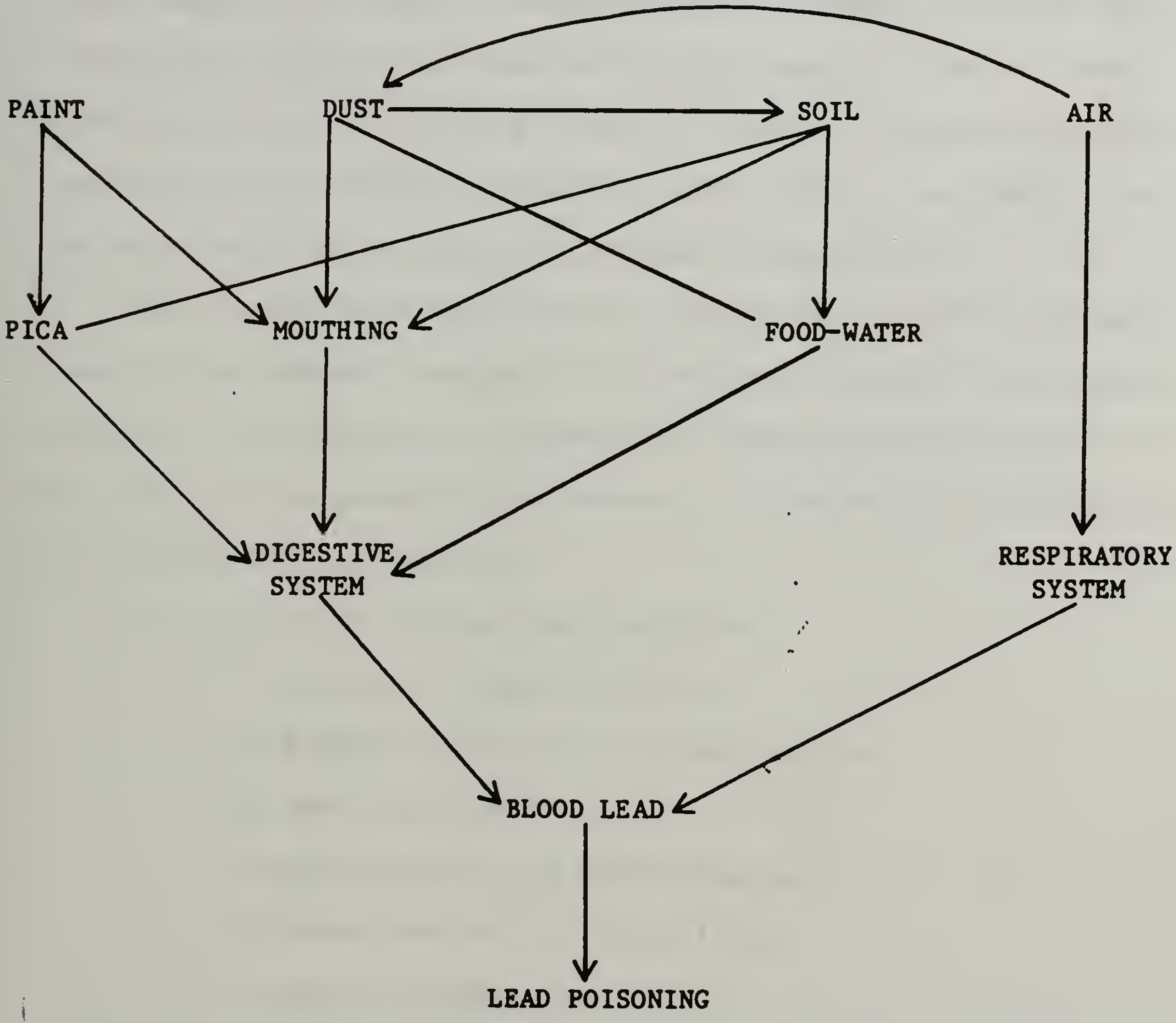


DIAGRAM 1: WAYS IN WHICH LEAD CAN ENTER THE BODY

---

[5] Health Hazard Evaluation Report, HETA 91-209-2249, "Seaway Painting Inc. Annapolis, Maryland", United States Government Printing Office, 1992, page 11

The severity of the lead poisoning is associated with the measurable amount of lead in the blood system. This measurement is called a blood lead level or BLL and is measured in millions of a gram per deciliter (ug/dl).[6] The exact amount of lead in ug/dl within a humans system that causes lead poisoning seams to be in dispute. From reviewing numerous articles dealing with the matter a specific safe level was not apparent. However, upper levels for adults and children were established and based on research.

This upper level for adults, 40 ug/dl, is the benchmark used by the federal regulators in the monitoring of lead paint removal.[7] Discussions on specific times for measurement of BLL will be discussed later, however, the effects of exceeding this level are as follows:

1) constipation and vomiting
2) apathy to hyperactivity
3) damage to central nervous system
4) hearing loss
5) convulsions and hemorrhaging
6) premature birth of children
7) severe headaches

---

[6] "House Subcommittee on Select Revenue Measures", One Hundred Second Congress, H.R. 2922, U.S. Government, page 148

[7] Health Hazard Evaluation Report, HETA 91-209-2249, "Seaway Painting Inc., Annapolis Maryland, U.S. Government Printing Office, 1992, page 12

8) death

There are other effects on children but this paper is concerned with the adult and how he/she reacts to lead poisoning.[8] [9]

A documented case of lead poisoning and how it occurs might best explain how serious of a problem it can be. The case involves a family renovating their own home, however, there are similarities to how paint is removed incorrectly from a structure if not informed of the paint's lead content.

> "A couple, with children and a pet, buy their first home as a haven for their family. They do some renovations, remove some paint, and paint the house. After living their for a few months the mother experiences a miscarriage. The doctor can find nothing wrong. Later the children begin experiencing flu like symptoms and the pet goes into a coma. The family takes the pet to a veterinarian who runs tests and determines the pet has lead poisoning. The veterinarian advises the couple to be tested by a doctor who determines they all suffer from some form of lead poisoning."[10] [11]

---

[8] Hearing before the Employment and Housing Subcommittee, One Hundred Second Congress, First Session, U.S. Government Printing Office, 29 April 1991, page 42

[9] Lin-Fu, Jane S.,"Children Today", U.S. Department of Health Education and Welfare, Jan-Feb 1979, page 3

[10] Hearing before the Employment and Housing Subcommittee, One Hundred Second Congress, First Session, U.S. Government Printing Office, 29 April 1991, page 44

As shown by this example, improper lead paint removal procedures are medically harmful. Furthermore, if left untreated these effects can permanently effect a person and even become fatal.

The family mentioned on the previous page did little to protect themselves during the renovation. Cloths were draped to catch the paint chips but constant traffic through the work area carried small chips and dust throughout the house. While removing the paint, no one used masks to protect themselves from inhalation of dust or ingestion of small paint particles. Simple precautions such as closing off the room to traffic and wearing a mask could have prevented this tragedy.

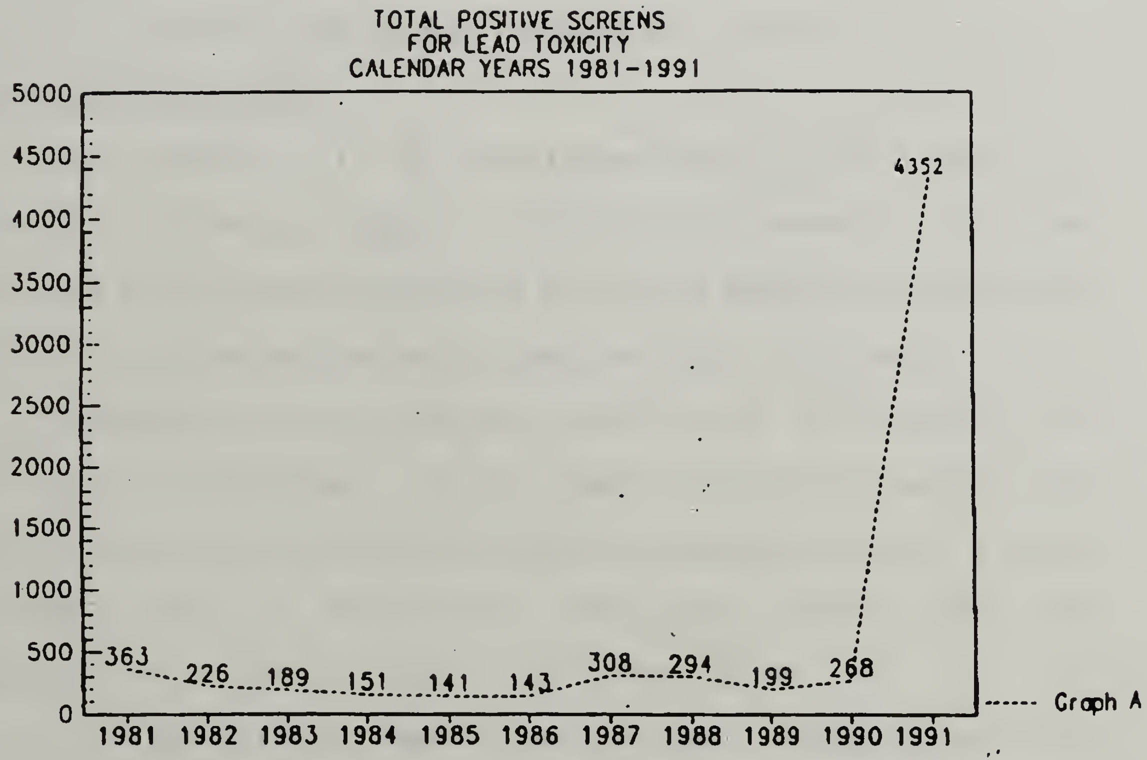
As shown on the following page, there has been recent increase in the number of cases involving lead poisoning. Although not all of these can be attributed to lead paint removal, the rise of this phenomenon should strike an alarm in an industry that is heavily involved with renovation of buildings. There is talk that lead paint abatement will be the asbestos of the 1990's but I believe through proper removal procedures combined with adequate precautions the expense of asbestos like removal can be avoided.

The following chapters will discuss various methods of removal and associated precautions that must be taken with the

---

[11] Hearing before the Subcommittee on Select Revenue Measures, One Hundred Second Congress, H.R. 2922, U.S. Government Printing Office, July 1992, page 46

removal process. From these selections a person can choose with method is best for the project they are undertaking.



TOTAL POSITIVE SCREENS FOR LEAD TOXICITY

CALENDAR YEARS 1981 TO 1991[12]

---

[12] Hearing before the Subcommittee on Select Revenue Measures, One Hundred Second Congress, Second Session, H.R. 2922, U.S. Printing Office, 1992, page 96

CHAPTER 3

This chapter will discuss various strategies of lead paint removal from a structure. The majority of this type of work will be exterior to a building or a structure but it also can be used for interior work of buildings. In dealing with lead paint there are four strategies that should be considered prior to selecting the actual method of removal.[13]

Maintenance in Place

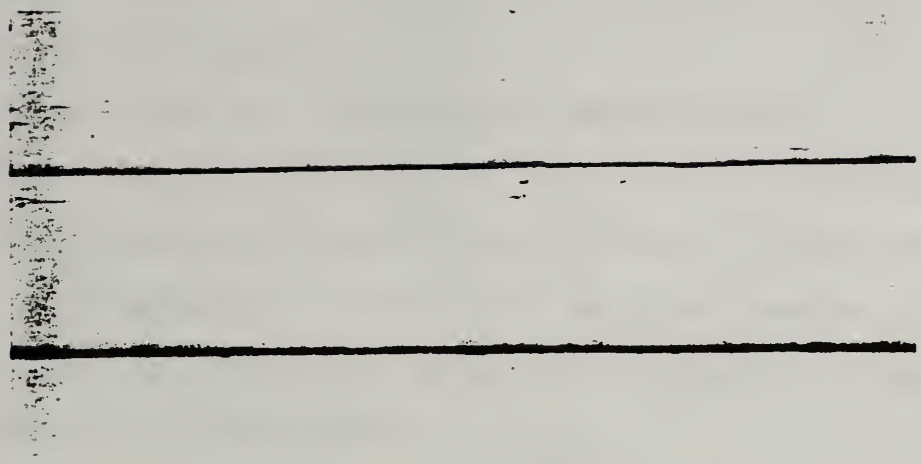
This option is to be considered only if the paint in place has not deteriorated. Visually it appears as if the paint has been recently applied with only minor scratches and dirt build-up being the only signs of wear and tear.

Preparation of the surface is limited to cleaning via some form of washing. At no time should the surface be subjected to an abrasion for limited removal. After proper cleaning occurs a topcoating should be applied that is compatible with the existing lead based paint.

Advantages of this method are obvious. Since no paint is being removed it does not require specific procedures for lead paint removal. Furthermore, there is no contamination of the job site by lead paint removal residue. Depending upon the actual condition of the existing lead paint and quality of the

---

[13] Trimber, Kenneth A.,"Industrial Lead Paint Removal Handbook", KTA-Tator Inc, 1990, page 21



EXISTING SURFACE THAT WOULD ONLY REQUIRE MAINTENANCE IN PLACE

topcoat, this strategy could provide proper encapsulation of the lead paint for five years or more.[14].

The major disadvantage of this strategy is that the lead paint could still be future environmental problem if proper maintenance does not occur or if regulations become more stringent.

Maintenance In Place with Limited Repair

This strategy should be considered when the surface in question is exhibiting limited deterioration of surface paint. This includes some pealing and/or minor cracking of the painted surface. The amount of pealing of cracking should be less than 5% of the painted surface. If a greater amount is

---

[14] Naval Facilities Engineering Command Presentation on Lead Paint Removal Handout, October 1990

detected maintenance in place with limited repair is not the suggested strategy.[15]

Removal of the cracking and chipping paint is normally performed via hand and/or minor power tools. The remainder of the existing surface should then be washed in accordance with industry standards. In order for the final product to have a smooth finish, minor putty work may be required in those areas receiving the repair work.

Topcoating then occurs in similar fashion as described in the Maintenance in Place method. Advantages to this strategy are minimum requirements for lead paint removal and clean-up. Costs are reduced by repairing only the needed areas and using the existing paint as a base.

Disadvantages include those presented in the prior strategy along with the costs associated with the minimum amount of hazardous waste (lead paint chips) generated.

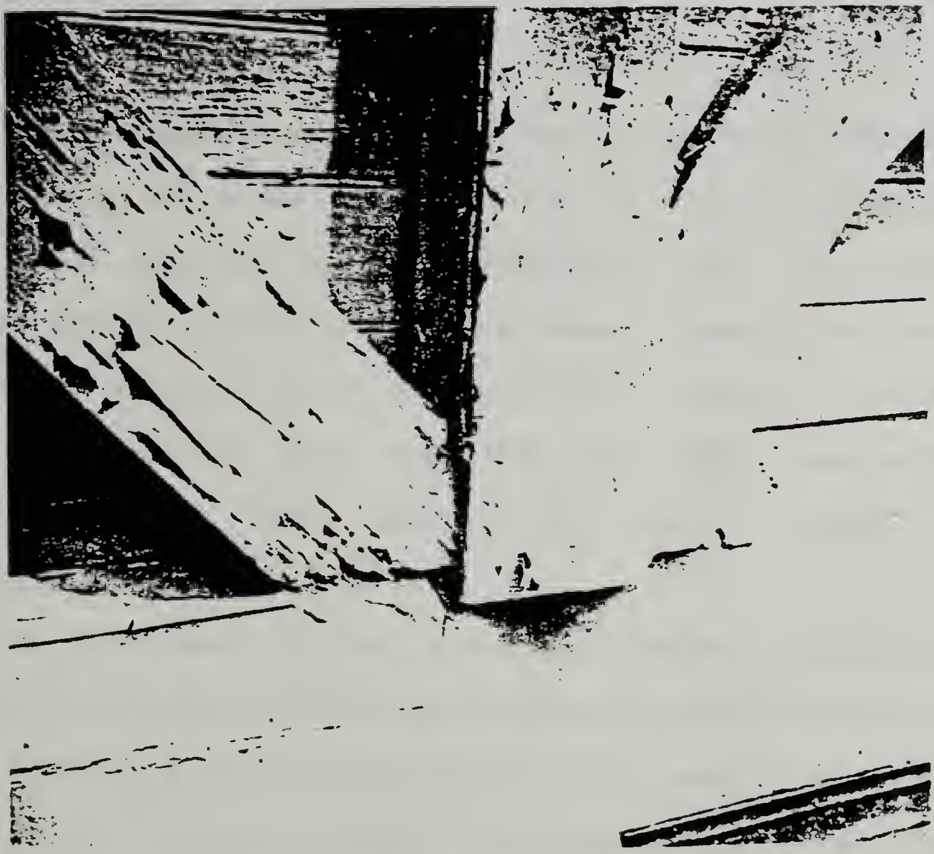
Limited Removal

This strategy should be invoked whenever deterioration of the primer and substrate is greater than 5% for the surface area considered.[16] The decision between this approach and complete removal is to be based on costs and predicted maintainability of the non-deteriorated existing lead paint.

---

[15] Naval Facilities Engineering Command Presentation on Lead Paint Removal Handout, October 1990

[16] Ibid



EXISTING SURFACE EXHIBITING MORE THAN 5% DETERIORATION

Removal of the deteriorated lead based paint can be carried out by a number of different techniques. Selection of which technique to use should be based in the overall size of the job and associated costs. However, whatever technique is selected some form of removal containment, personnel protection and hazardous waste disposal will be required.

Advantages and disadvantages of this method are similar to those discussed in the previous strategy with the advantages being minimized to some degree and the disadvantages growing in magnitude.

These first three methods that have been described all have the major disadvantage of maintaining a structure with lead paint that has been encapsulated. This could result in future removal costs in excess of what it would cost to remove it today along with a potential for future environmental impact depending upon new EPA and FDER regulations or interpretations. This leads to the final strategy:

Complete Removal

As the name of the strategy implies, lead paint is completely removed from the structure by some technique or if wood siding is the object of the job, removal of the siding itself could be an option. The selected technique again should be based on all costs associated with the removal, clean-up and repainting.

The major advantage to this strategy is a structure free from lead paint and all the medical and environmental impacts associated with that hazardous substance.

Cost is the major disadvantage. Containment and containment removal along with personnel protection and disposal of the lead paint could add up to a dollar figure that is more than 25% of the overall project costs.[17]

Now that strategies have been discussed the actual type of removal method must be selected. These methods are varied

---

[17] U.S. Department of Commerce, "Lead Paint Abatement Costs", U.S. Government Printing Office, 1979, page 89

and have their own particular advantages and disadvantages. Each will be discussed in detail in the following chapter.

CHAPTER 4

Currently, costs associated with removal and disposal of lead paint from residential, non-residential and industrial can range anywhere from $3.00 per square foot to $10.00 per square foot.[18] This cost is highly dependent upon the technique used and could increase if abatement procedures are not correctly followed. The following techniques or methods are those currently being used in the industry today. Some of the examples given will be from personnel experience and will state such at that time.

Hand Tool Cleaning

This includes any manually operated scrapping, sanding or impact type of tool being applied to the surface for removal of the lead based paint. The cost and duration of this process is dependent upon:

- wage rates of the workers involved in the removal
- amount of abatement and personnel protection required
- square footage of lead paint removal area[19]

This method is best suited for the three strategies previously discussed that deal with limited lead paint

---

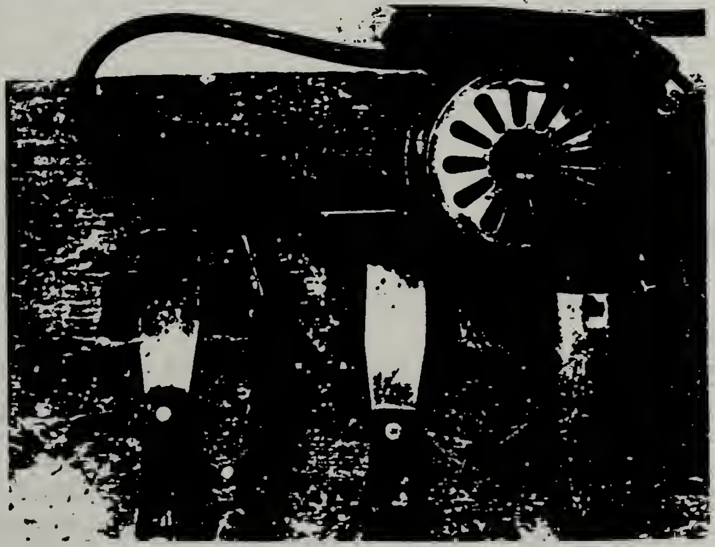
[18] Naval Facilities Engineering Command Presentation on Lead Paint Removal, October 1990

[19] U.S. Department of Commerce, "Guidelines for Cost-Effective Lead Paint Abatement", U.S. Government Printing Office, 1979, page 29

removal. Time constraints make it unfavorable for complete removal practices unless the paint is in such disrepair that scrapping can be accomplished easily and quickly.

From personnel experience of two contracts that were managed at my last duty station, this method is both cost effective and simple. It does not get involved with detailed removal plans, however, a "certified industrial hygienist" approved removal plan was required. (This requirement by the owner is highly recommended and will be discussed in a later chapter.)

Personnel protection was limited to goggles, surgical masks and protective clothing. The lead chips were collected daily and placed in a storage drum along with any contaminated material. These drums, when full, were collected and disposed in accordance with FDER and EPA requirements. The objective of both of these contracts was removal on areas where paint failure had occurred and encapsulation of the remaining lead paint.



HAND TOOLS AND HEAT GUN USED IN PAINT REMOVAL

Electrical Heat Gun

This process is used in conjunction with the hand tools mentioned above. When paint is heated sufficiently, it softens, swells and/or blisters to a point that it can easily be removed by a scrapper.[20] This device is similar to a hair dryer in concept but is manufactured for commercial and industrial use.

Caution should be used when considering this device for lead paint removal. Temperatures should not exceed those where the lead in the paint is released as a gas that could be inhaled by the operator or other workers. An air sample should be taken during a demonstration of the heat gun's use to determine if respirators would be required.

If the situation described above does not occur, this method should decrease the time involved for removing the lead paint. Depending upon the thickness of the paint layers, this method could be used for complete removal on certain types of jobs.

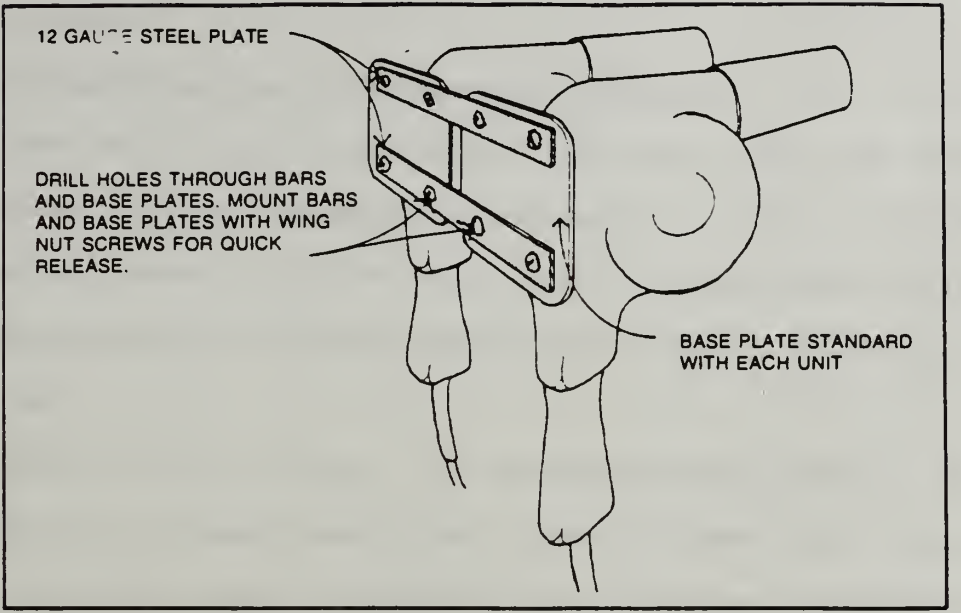
It should be noted that research has indicated that this method of removal is safe and does not pose a fire hazard.[21] Besides the use of protective gloves the same requirements as used in hand scrapping are applicable. However, even though data indicates that this is a safe method of operation, care

---

[20] U.S. Department of Commerce, "Lead Paint Abatement Costs: Some Technical and Theoretical Considerations", U.S. Government Printing Office, 1979, page 35

[21] Ibid, page 35

is advised around older wooden structures where the heat of the gun could possibly cause combustion concerns.


12 GAUGE STEEL PLATE
DRILL HOLES THROUGH BARS AND BASE PLATES. MOUNT BARS AND BASE PLATES WITH WING NUT SCREWS FOR QUICK RELEASE.
BASE PLATE STANDARD WITH EACH UNIT

METHOD USED TO JOIN TWO SMALL HEAT GUNS[22]

Power Tool Cleaning

Loose paint is removed by the application of power-operated impact, grinding, or brushing tools. This method has a time advantage over hand tools. Also, these tools are usually more effective in the removal operation but have a tendency to gouge wood if used incorrectly.[23]

Another disadvantage in the comparison with hand tools is the scattering of paint chips over a wider drop area causing

---

[22] O'Bright, Alan, "Paint Removal from Wood Siding", Tech Notes: U.S. Department of the Interior, U.S. Government Printing Office, 1986, page 4

[23] Naval Facilities Engineering Command Presentation on Lead Paint Removal Handout, 1990

larger clean-up problems and the possibility of creating a fine dust which would require the use of respirators and containment.[24]

Power Tool Cleaning with Vacuum Attachment

The same power tools described above are used within a localized vacuum equipped containment.[25] This containment system surrounds only the tool itself. The overall effect is a large reduction in paint dust and scattering of chips is not as great.

These type of tools are expensive and require special training for proper operation. Use of these tools does not guarantee that OSHA or FDER will not require respirators and additional containment. Also, for proper vacuum operation the process is slow and the time advantage gained by power tools over hand tools is minimized.

Chemical Strippers

There are many types of chemical paint strippers on the current market. They all perform in the same basic manner. The chemical is applied to the structure via spraying or some form of troweling operation. A period of time is then allowed to elapse and then the chemical along with the removed paint is scrapped from the structure. This residue (without the

---

[24] Code of Federal Regulations [1989],29 CFR, Part 1910.1025, Washington D.C., U.S. Government Printing Office, page 158

[25] Naval Facilities Engineering Command Presentation on Lead Paint Removal Handout, 1990

presence of lead paint) is a hazardous waste itself and must be dealt with appropriately.[26]

Although this is an easy and quick process it does have many drawbacks. As already discussed the residue produced is a hazardous waste. Complete removal of the paint on the structure is not guaranteed and other forms of removal may be required. Plus, other problems, if not properly applied. The best way to discuss this is to give a brief outline of a Navy contract job that went bad.

The U.S. Navy let a job to have the paint removed from the Admiral's Quarters on one of their bases. After the first application of the stripper it was noted by all parties that very little paint was removed. The contractor stated that this was due to the thickness of the paint on the building and further applications would be required (paint thickness was in excess of 1/8" in places).

After repeated applications of the stripper and a satisfactory job had been accomplished. This is where things began to happen. Areas of wood that had been cleanly stripped in the first application had become soaked with the stripper causing three things:

1) much of the wood work was saturated with stripper

---

[26] Consumer Product Safety Commission, "Stripping Paint from Wood", U.S. Government Printing Office, 1991

2) the wood leached this chemical after the containment system had been removed and contaminated the ground surrounding the Quarters

3) the wood repelled painting efforts by the contractor

This is an indication of what could go wrong in using a chemical stripper. The owner must be sure the contractor is trained in this area of paint removal and the contractor needs to determine if chemical stripping is appropriate for the type of job.

Open Expendable Abrasive Blast Cleaning

This method of paint stripping involves the use of compressed air to propel abrasive particles against the painted surface. The abrasive particles are usually sand or some other form of inexpensive grit since the media along with the paint debris will be disposed of after operation.

Advantages of this method are ease of operation and an evenly cleaned surface if used properly. The reduction in time and personnel required usually offset the cost of the machine and the media.

Disadvantages are many. The operation causes the paint to become a fine dust that will require the operator to wear a breathing apparatus. If the concentrations of dust particles exceeds EPA and FDER air standards, a containment

system around the operations will also be required.[27] Additionally, the amount of hazardous waste created by this process has been greatly increased. The abrasive material is mixed with the lead paint particles making the entire mixture a hazardous waste. These additional precautions result in an increased cost that may exceed expectations.

Open Recyclable Abrasive Blast Cleaning

Recyclable Abrasive Cleaning is very similar to the previous method with the exception being that the abrasive media used is recyclable. Typically the media used is metallic and a magnetic retrieval system is used to separate and retrieve the media from the debris.[28]

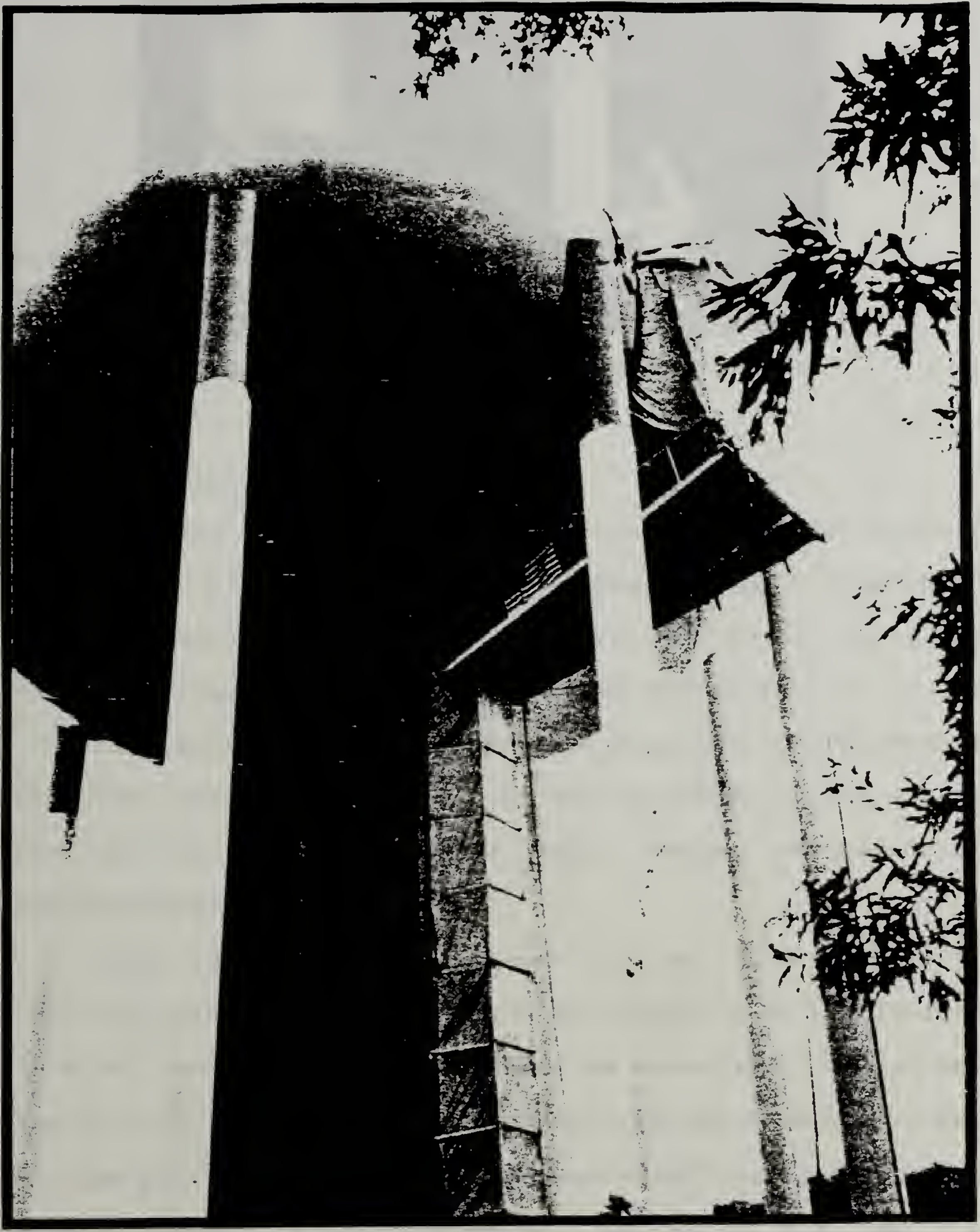
This method's advantage over the previous process is the separation of media from the hazardous lead paint debris. It is not achieved without cost. The separation machine is an additional expense and time is consumed in separating the media from the debris. All the other disadvantages remain.

A variation of this process is the use of ice pellets as the media which requires no retrieval, however, a damn type containment system is required to hold the water once the ice melts.

---

[27] Conversation with C.W. Salmon, FDER Air Program Compliance Coordinator, Northwest District, 29 April 1993

[28] U.S. Department of Health and Human Services, "Health Hazard Evaluation Report, Seaway Painting, Inc., Annapolis Maryland", U.S. Government Printing Office, 1992, page 4



CONTAINMENT SYSTEM FOR ABRASIVE BLASTING OF A WATER TANK[29]

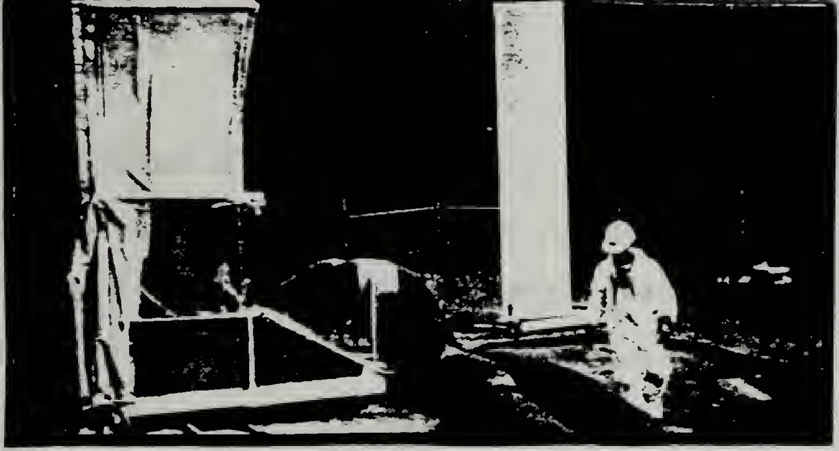
---

[29] U.S. Department of Health and Human Services, "Health Hazard Report Evaluation, Seaway Painting Inc., Annapolis Maryland", U.S. Government Printing Office, 1992, figure 1

[illegible]

[illegible]

[illegible]



EXHAUST PLENUM AND WORKER IN PROTECTIVE SUIT[30]

Abrasive Blast Cleaning with Vacuum

A closed system by which the blast nozzle is tightly fitted into a localized containment assembly which is equipped with a vacuum system. All dust, abrasive and paint debris are collected simultaneously by the vacuum operation.[31]

This system can use either non-recyclable or recyclable abrasive. The more efficient of the two would be the later. Removing the abrasive from the debris reduces the amount of hazardous waste produced.

Blast cleaning with a vacuum is a very slow process in that the operator must stay in close proximity of the surface in order that all debris along with the abrasive is collected. Any deviation will cause a breach in the containment system. The operator is still required to wear breathing apparatus and a suit, however, a full containment may not be required.

---

[30] U.S. Department of Health and Human Services, "Health Hazard Evaluation Report, Seaway Painting Inc., Annapolis, Maryland", U.S. Government Printing Office, 1992, figure 3

[31] Naval Facilities Engineering Command Presentation on Lead Paint Removal, Handout, 1990

Wet Abrasive Blast Cleaning

Water is injected into the compressed air/abrasive mixture prior to contacting the painted surface. This process eliminates the dust created during normal abrasive blasting procedures. The advantage gained by the water injection is offset by the fact that a catch basin system must be created to collect the water, debris and abrasive mixture for proper hazardous waste disposal.

Increased cost is incurred in the disposal process due to the magnitude of lead tainted water waste created. A process of filtering the water-debris mixture prior to drumming for hazardous waste is available but it is very time consuming. Stripping must be kept at a pace that does not exceed the filtering process and containment capacity if it is done on the job site.

Pressure Water Jetting

Pressurized water is directed against the surface to remove the paint. This operation can be divided into three groups:[32]

1) low pressure: less than 10,000 psi
2) high pressure: 10,000 to 20,000 psi
3) ultra high pressure: above 20,000 psi

---

[32] Naval Facilities Engineering Command Presentation on Lead Paint Removal, Handout, 1990

The same disadvantage described in the previous method applies. Since the process does not use an abrasive the filtering is more efficient but still tedious.

High pressured water is not advisable on housing type structures. The water will find small seams between walls, windows and doors, causing damage to the interior of the structure. If water seepage will cause damage to the interior of any structure, no matter how it is constructed, pressure water jetting should not be considered an option for the removal of the paint.

A variation of this method is the introduction of abrasive materials into the water stream. This is very similar to wet abrasive blast cleaning and has the same advantages and disadvantages.

Combinations of Removal Methods

Normally, one of the prior mentioned methods will not completely remove the lead paint from the structure's surface alone. Therefore, it is necessary to use another method in conjunction the primary method selected in order to entirely remove the paint if that is the goal.

Selection of methods should be based on the project itself, strengths and weaknesses of each and insurance that compatibility with each other and the repainting can occur.

Through a combination of methods a reduction in cost and containment can occur.[33]

Removal of Surface

A cost comparison of stripping versus removal of the painted surface should be conducted. If the surface is deteriorated to such an extent that replacement is required, the lead paint should be left on and disposed with the surface in question.

Majority of the time, especially with wood, the removed surface with the lead paint attached will pass current lead testing procedures enabling the surface to be disposed of as a normal construction debris and not a hazardous waste.[34]

In the case of wood siding on a house, it may be more effective to entirely remove all the wood with the lead paint intact instead of stripping.[35] This eliminates the time involved for permitting and submittals for hazardous waste removal along with the elimination of disposal costs. In the instance referenced above it was found that an overall cost savings would occur if re-siding was used instead of stripping and repainting.

---

[33] Snyder and Bendersky, "Removal of Lead Based Bridge Paints", National Cooperative Highway Research Report 265, Printed in the U.S.A., 1983, page 2

[34] Conversation with Art Leskowich, FDER Hazardous Waste Disposal Coordinator Northwest District, 27 April 1993

[35] "Background Discussion and Plan of Action and Milestones on Exterior Re-siding and Painting of Flag Quarters", Southern Division Naval Facilities Engineering Command, 1991

Discussion on Costs

Listed below are some costs associated with various methods described above. These costs are not to be used as gospel, however, they are a good comparison of actual costs for similar sized projects in the same geographic area.[36]

Abatement Method	Cost per Linear Foot
Heat Gun	$4.41
Hand Scraping	$5.57
Chemical Stripping	$8.50
Heat and Scraping	$4.94
Replacement	$9.15

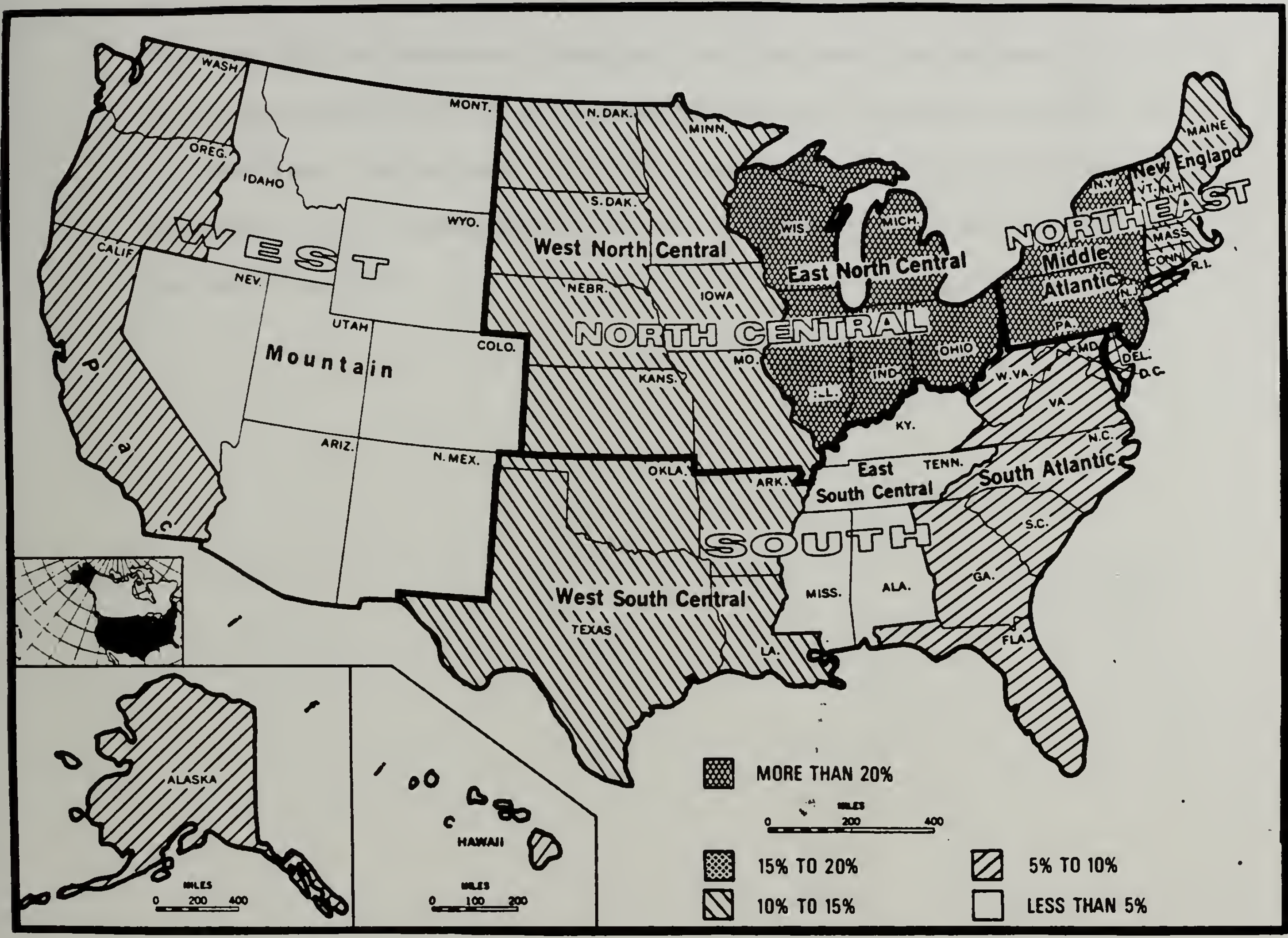
These costs do not include disposal costs of the removed lead paint. This cost is solely dependent on the amount of debris collected from the job site. This debris is collected in EPA approved drums and are then shipped to a local approved hazardous waste site. The cost per drum is approximately $350.00 which includes administrative and local shipping. This cost does not include the cost of the drum, permitting form hazardous waste removal, hazardous waste protection costs or long haul shipping out of the area.[37]

All these costs are also site specific. A research of lead paint abatement costs throughout the U.S. follows:

---

[36] U.S. Department of Commerce, "Guidelines for Cost-Effective Lead Paint Abatement", U.S. Government Printing Office, 1979, pages 28 and 34

[37] Conversation with D. Chasting of Naval Public Works Center, Pensacola, Florida, 29 May 1993



DISTRIBUTION OF INCREASED LEAD ABATEMENT COSTS BY REGION[38]

---

[38] U.S. Department of Commerce, "Lead Paint Abatement Costs: Some Technical and Theoretical Considerations", U.S. Government Printing Office, 1979, page 29

Actual costs for a specific project should be determined locally with comparisons made between specific methods. To assist in this effort some work-sheets with risk weight factors and a computer program is included in Appendix A.[39] With the availability of hazardous waste disposal sights on the decline, the volume to be disposed along with the shipping distance will become the critical factor in the selection of the best method.

---

[39] U.S. Department of Commerce, "Lead Paint Abatement Costs: Some Technical and Theoretical Considerations", U.S. Government Printing Office, 1979, pages 97-138

CHAPTER 5

The Occupational Safety and Health Administration (OSHA) outlines very specific guidelines for workers who come in contact with lead. Although these guidelines are written for the employer (usually the contractor), it is imperative that the owner of the structure be aware of all safety procedures required in order to avoid litigation if lead poisoning as a result of the abatement. The contractor is ultimately responsible for the safety of his employees, however, if contributory negligence can be proven, the owner of the structure may find himself involved in a law suit.

OSHA requirements for working in a lead contaminated surrounding are found in Title 29 Code of Federal Regulations, Part 1910.1025. The is based on the knowledge that there is a lead presence in the working atmosphere. To become aware of this fact, testing of the paint to be removed must be performed.

Initial testing is the responsibility of owner. In preparing plans and specifications for any project, the owner is responsible for providing the prospective contractor all information concerning the project including any potential hazards. This should include testing of any painted surface that is to be stripped or have welding operations performed. Reliance that the building contains no lead painted surface due to recent construction or rehabilitation may prove to be

a fatal mistake. Leaded paints are still used in the protection of steel and a rehabilitation project may have encapsulated rather than removed the lead paint.[40] Therefore, in preparing for a paint stripping or welding job, it should be assumed that lead paint exists unless testing of the surface proves otherwise.

Furthermore, a contractor coming on a job site should also perform a test for lead content of painted surfaces. This should be done whether or not lead paint removal is indicated in the contract.

If the specifications do indicate that lead paint is present another test will verify to all that the expensive procedures that are about to be undertaken are necessary. However, if a negative test results, this could be an indication of surfaces with both leaded and non-lead type paints. Further tests can then be performed with possible savings to the owner and reduced effort by the contractor.

On the other hand, if lead paint is not identified in the contract, a prudent contractor should still test in order to promote the safety of his employees.

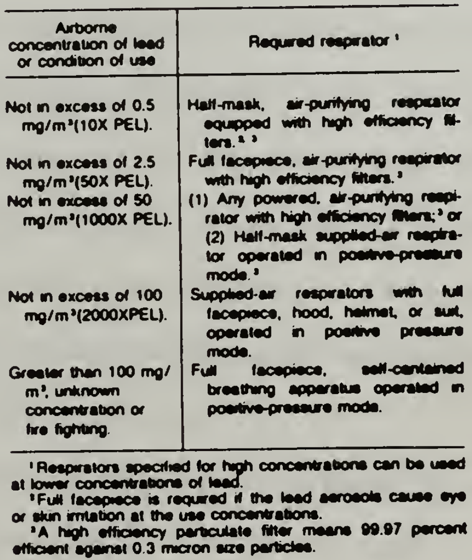
It is now known by the contractor that his employees will be working in a environment where they are exposed to the hazards of lead poisoning. The employer shall notify each

---

[40] Chute and Mostaghim, "Protecting Workers from Lead: A Review of Regulations and Practices", Journal of Protective Coatings and Linings, April 1991, page 36

employee, in writing, of this fact.[41] This notice will contain information on the test method used and the accuracy of the analysis.

At this point the services of a Certified Industrial Hygienist should be employed in order to determine the protective measures required. This will include further testing during a demonstration of the proposed method for removal.[42] Air samples will be taken to determine if the use of respirator equipment will be required. A table outlining required respirator type as a result of the test follows:



Airborne concentration of lead or condition of use	Required respirator [1]
Not in excess of 0.5 mg/m^3(10X PEL).	Half-mask, air-purifying respirator equipped with high efficiency filters.[2, 3]
Not in excess of 2.5 mg/m^3(50X PEL).	Full facepiece, air-purifying respirator with high efficiency filters.[3]
Not in excess of 50 mg/m^3(1000X PEL).	(1) Any powered, air-purifying respirator with high efficiency filters;[3] or (2) Half-mask supplied-air respirator operated in positive-pressure mode.[3]
Not in excess of 100 mg/m^3(2000XPEL).	Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive pressure mode.
Greater than 100 mg/m^3, unknown concentration or fire fighting.	Full facepiece, self-contained breathing apparatus operated in positive-pressure mode.

[1] Respirators specified for high concentrations can be used at lower concentrations of lead.

[2] Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

[3] A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron size particles.

RESPIRATORY PROTECTION FOR AIRBORNE LEAD LEVELS

---

[41] Code of Federal Regulations [1989], Title 29, Part 1910.1025, Washington D.C., U.S. Government Printing Office, page 158

[42] Conversation with Carolyn W. Salmon, Air Program Coordinator, Northwest District, Florida Department of Environmental Regulation, 29 April 1993

This table, although established for lead aerosol use, has been interpreted by the FDER as a guidelines for use in any industry or operation in which lead particles become airborne.[43] If the test results of the lead paint removal are below detectable limits, masks will still be required as part of the operation.

OSHA is very specific about the respiratory program that will be used. The program will contain the following:[44]

1) respirators will be provided to all employees at no cost to the employee
2) an employee can select another respirator of equal or better protection at no cost
3) employers shall perform face fit tests
4) filters will be provided at no cost to the employee and in an adequate supply
5) employers shall institute a respiratory protection program in accordance with 29 CFR 1910.134
6) maximum negative pressure respirator use is limited to 4.4 hours a day

Further protective requirements of this act include the use of protective clothing. If an employee is exposed to

---

[43] Conversation with Carolyn Salmon, Air Program Compliance Coordinator, Northwest District, Department of Environmental Regulation, 29 April 1993

[44] Code of Federal Regulations [1989], 29 CFR, Part 1910.125, Washington D.C., U.S. Government Printing Office, page 160

lead, as determined by appropriate testing (even if respirators are not required), protective clothing will be required. The protective clothing and equipment will be provided by the employer at no expense to the employee. This clothing and equipment includes, but is not limited to:[45]

1) coveralls or full-body clothing
2) gloves, hats, shoes or deposable shoe covers
3) protective eye equipment IAW 29 CFR Part 1910.133

The employer is also responsible for cleaning, at least on a weekly basis, and replacement of the provided articles if damage occurs.

Another provision that OSHA mandates is the preparation of a Compliance Program. These programs detail how exposure levels will be reduced to an acceptable level for the employees. Written plans shall include as a minimum the following details:[46]

1) a description of each operation in which lead is emitted, including collection guidelines
2) a description of methods to achieve compliance
3) a technology report
4) air monitoring data
5) a schedule of implementation
6) a work practice program

---

[45] Code of Federal Regulations [1989], 29 CFR Part 1910.1025, Washington D.C., U.S. Government Printing Office, page 161

[46] Ibid, page 159

7) an administrative control schedule

8) any other pertinent information

A successful and acceptable program will require the use of an expert in industrial hygiene along with the cooperation of members of a firms staff and their employees. This plan should be a submittal requirement by the owner and is a mandatory requirement by OSHA.

Code of Federal Regulations, 29 CFR, also details the use of mechanical ventilation as a means to control exposure limits. This sounds similar to methods used in asbestos removal. It may not eliminate the need for a respirator but use of ventilation could allow a less stringent type of respirator as per the earlier discussion on this subject. If this practice is to be considered, caution must be exercised in the location of the exhaust vent.[47]

Housekeeping and cleaning are important considerations in a safe lead paint removal procedure. All surfaces other than the one being stripped should be kept free of accumulations of lead chips and dust. The use of compressed air is strictly prohibited by OSHA for this procedure, however, special vacuums that contain their own exhaust are allowed. Other methods described include shovelling, wet sweeping and

---

[47] Code of Federal Regulations [1989], 29 CFR, Part 1910.1025, Washington D.C., U.S. Government Printing Office, page 159

brushing, but are to be used only when vacuuming was found to be ineffective.[48]

Hygiene practices concern themselves with educating the employees on proper procedures that must be followed prior to consumption of food, water or smoking and prior to leaving work. If required, guidance on showers, change rooms, lunchrooms and lavatories is outlined in the 29 CFR. These last few items would have to be considered if full containment was required due to air emissions. This type of requirement falls under the EPA's 40 CFR and will be discussed later.

Biological monitoring of all employees exposed to lead is a requirement the employer must meet to comply with OSHA. This requirement is also a sound business practice. Records can be kept indicating that will employed for a firm, an individuals health was maintained in respect to blood poisoning. It also allows early detection for treatment.

The biological monitoring consists of blood sampling that will be analyzed for the presence of lead and zinc protoporphyrin (zpp).[49] A blood sample should be obtained and analyzed prior to an employee beginning work in a lead tainted environment. This accomplishes two objectives:

1) establishes a baseline from which to gauge any exposure

---

[48] Code of Federal Regulations [1989], 29 CFR, part 1910.1025, Washington D.C., U.S. Government Printing Office, page 161

[49] Ibid, page 162

2) possible detection of personnel who unknowingly are experiencing low level lead poisoning

As discussed earlier the permissible maximum BLL is 40 ug/dl. Follow-up blood tests are required every six months or sooner if a specific abatement job is completed prior to this time. If this level is exceeded, those individuals should be removed from the lead abatement area and medical treatment plus bi-monthly follow-up tests are required. Any associated medical treatment costs are the responsibility of the employer.[50]

A complete medical examination of all employees that will be involved with lead paint abatement should be conducted:[51]

1) at least annually
2) prior to first time assignment
3) as soon as symptoms develop
4) other limitations under 29 CFR

This examination is not limited to blood testing. It is to include a survey of personnel habits, past medical history and family medical history. A visual physical examination of areas which are affected by lead poisoning, such as gums, teeth and renal system is required. Plus blood pressure, urinalysis and any other test which a physician deems necessary are part of the physical.

---

[50] Code of Federal Regulations [1989], 29 CFR, Part 1910.1025, Washington D.C., U.S. Government Printing Office, page 162

[51] Ibid, page 163

Furthermore, if requested by an employee, pregnancy and fertility testing should be conducted with the employer bearing the cost. The employee also has the right to request a second opinion or request the use of a personnel physician to conduct the test. An employer may condition payment for these requests. A very detailed explanation on resolving differing determinations by two doctors is presented in OSHA, 29 CFR.[52]

As with any federally regulated operation, record keeping is a necessary evil of monumental proportions. Record keeping is broken into three specific areas. These areas are exposure monitoring, medical surveillance and medical removals.[53]

The exposure monitoring record is to include dates, number, location and results of all samples taken. Descriptions of sampling method and any protection used during the sampling. Also, very specific information including name and social security number of all employees exposed during the abatement. This record shall be maintained for 40 years or the duration of employment plus 20 years, which ever is greater.[54]

---

[52] Code of Federal Regulations [1989], 29 CFR, Part 1910.1025, Washington D.C., U.S. Government Printing Office, page 162

[53] Ibid, page 168

[54] Ibid, page 168

Medical surveillance records are kept in conjunction with various subsections of the 29 CFR. This record, which must be maintained by the employer for the same time specified in the the exposure monitoring, shall include as a minimum:[55]

1) the name, social security number and duties of all exposed employees
2) physician's opinions
3) airborne monitoring results
4) any medical complaints
5) all medical records

Many of these requirements are similar to the exposure monitoring records which should help somewhat in the reduction of administrative work.

Medical removal records almost duplicate the previous record requirements with specific criteria for the reason why removal and subsequent reinstatement occurred. These records need to be maintained by the employer for the duration of the employees employment.[56]

These records must be made available to the Occupational Safety and Health Administration upon request for examination and if deemed necessary, copying. Employees may also request to examine and copy their own personnel records.

---

[55] Code of Federal Regulations [1989], 29 CFR, Part 1910.1025, Washington D.C., U.S. Government Printing Office, page 168

[56] Ibid, page 169

The employer must transfer custody of the records if the firm ceases operation. In the case where a firm is taken over or sold to another company, that successor company is then responsible for maintenance and upkeep of the records as specified by the Act. If, in case where the firm simply ceases to exist, the records are to be transferred to OSHA directly.[57]

An employer is also required to notify the Director of OSHA at least three months prior to the expiration of the mandatory maintenance period if the intent is to dispose of said records at the end of the period.[58]

As shown, the guidance under OSHA for the removal of lead paint very specific. The regulations are designed for the protection of the worker and to ensure employer involvement in attaining a safe working environment. However, as stated at the beginning of this chapter, the owner of the project receiving lead abatement, if different from the worker's employer, should be familiar with these regulations.

Along with the possibility of litigation, there are other reasons for knowledge. If the owner wishes to inspect the premises during the abatement, his inspector will be subject to the guidance put forth under 29 CFR. This inspector will also need knowledge of the regulations in order to assure that

---

[57] Code of Federal Regulations [1989], 29 CFR, Part 1910.1025, Washington D.C., U.S. Government Printing Office, page 169

[58] Ibid, page 170

proper documentation and testing is being performed by the contractor throughout the lead abatement process.

Knowledge of the scope of these regulations will also give an individual an understanding of the reasons why lead abatement costs are more expensive then typical paint removal costs. The numerous testing, medical and administrative requirements all add to the cost that must be recuperated under the contract. The first two items listed above are fairly easy to estimate unless and unforeseen condition occurs. Unfortunately, the administrative costs can only be roughly estimated.

This is due to the unknown period of how long the employer must keep the records and will any future legislation or administrative procedure place more severe record keeping requirements causing a further increase in costs. The employer must guess at a reasonable value that will allow him to maintain his competitive edge along with compensating for costs.

The purchaser of a lead paint abatement contract should consider these cost items prior to judging its' value. These items should be considered in formulation of the original contract estimate along with any change order that might occur under the contract. Plus, the owner will be faced with additional costs of either training his inspectors and meeting OSHA requirements or letting of a separate contract to a firm

that specializes in the inspection of hazardous waste operations.

As shown, knowledge of 29 CFR regulations is a must for all parties involved in a lead abatement project. A copy of the 29 CFR can be found in Appendix B in its entirety.

CHAPTER 6

Neither the Environmental Protection Agency (EPA) nor the Florida Department of Environmental Regulation (FDER) have specific regulations or guidelines concerning the removal of lead paint. Although detailed guidance is provided by these environmental watchdogs for the removal of specific items such as asbestos, it is almost non-existent for lead abatement. However, this does not mean that lead paint removal procedures are not addressed in some form. Both of these agencies are responsible for the protection of the environment along with safeguarding the public from exposure to hazardous materials.

The EPA covers the lead paint abatement process under the Code of Federal Regulations, 40 CFR, Part 261, Hazardous Wastes. This code is fairly generic and covers a multitude of contaminants, one of them being "lead".[59] The FDER interprets this document as the guidance on lead paint removal and disposal procedures in conjunction with the applicable OSHA standards discussed in the previous chapter.[60]

An obvious problem with this situation is the inconsistency that could and does occur in the interpretation of the code. Discussions with colleagues doing similar work

---

[59] Code of Federal Regulations [1989], Environmental Protection Agency, 40 CFR, Part 261, Washington D.C., U.S. Government Printing Office, page 47

[60] Conversation with Carolyn W. Salmon, Air Program Compliance Coordinator, Northwest District, FDER

at various areas in the country indicate a wide range of 40 CFR renderings. Situations existed where very strict controls consisting of total containment systems being required to where no protective requirements at all were revealed during these talks. It is evident that a consistent national policy should be established, but until that occurs a knowledge of the code and the requirements it contains are necessary for all parties involved in lead paint abatement.

The first step into the realm of the 40 CFR, Part 261.30 is selection of the removal process. All types of removal outlined in a previous chapter will require that an air emissions test be performed in order to determine if and the extent of a containment barrier requirement.[61] Although this determination of air quality is testable the actual requirement for containment can be made by an interpretation of other guidelines as determined by the local environmental agency. Other areas of concern as determined by the local official are possible contamination of water supplies, contamination of soil and thereby contaminating aquifers and fallout of lead particles in residential areas. The last item mentioned was the reasoning at a recent water tower project in the Pensacola, Florida area.

A public funded contract was awarded for the repainting of a water tower in Pensacola. The contract called for the

---

[61] Code of Federal Regulations [1989], Environmental Protection Agency, 40 CFR, Part 265.1, Washington D.C., U.S. Government Printing Office, page 431

complete removal of all paint prior to repainting. Contract specifications included the fact that lead paint was present and appropriate precautions should be taken during its removal. The area FDER District determined that even though the method to be employed did not require complete containment as per 40 CFR Part 261, due to possible lead chip and dust fallout in surrounding residential areas, complete containment was ordered in accordance with other sections of 40 CFR.[62] This is a prime example of how complete knowledge of the regulations is required. Although Part 261 of 40 CFR deals specifically with hazardous materials and waste, many other sections apply.

The remainder of this chapter will deal with the basic requirements of 40 CFR Part 261 in order to give an understanding of minimum details involved in lead paint abatement. However, prior to contracting for or performing such an abatement procedure it is recommended that all parties contact an expert in this field and use that expertise for their purposes.

If the removal process selected creates a fine dust, such as media blasting, it will require that an air permit be obtained from the FDER.[63] This process will also require

---

[62] Conversation with Carolyn W. Salmon, Air Program Compliance Coordinator, Northwest District, Florida Department of Environmental Regulation, 27 April 1993

[63] Code of Federal Regulations, Environmental Protection Agency, 40 CFR, Part 265, Washington D.C., U.S. Government Printing Office, page 433

containment of the area being blasted during those operations. Containment can range from total to specific areas which is dependent upon the abatement procedures used. Partial containment can be used where the lead paint is removed in small sections and that area is repainted prior to proceeding to the next area. However, if removal of the lead paint can not be performed in definite sections and a shotgun approach is to be used, complete containment of the surface will be required. Effectiveness and costs of certain containment systems are given at the end of this chapter.

In performing lead paint removal on low profile structures (overall height not in excess of two stories), containment of the surface may not be required if hand removal methods are used. However, protection of soil and water will be required along with providing a means of collecting all paint chips.[64] This process of not using an airborne containment system is allowed based on the condition that paint removal will not occur if winds exceed a specified limit.

Containment will not be required if the paint removal process selected does not create a hazardous waste as defined by the 40 CFR. In determining if paint is indeed hazardous due to lead content there are two preferred methods of testing. These two tests are the Toxicity Characteristic

---

[64] Code of Federal Regulations [1989], Environmental Protection Agency, 40 CFR, Part 261.33, Washington D.C., U.S. Government Printing Office, page 54

Leaching Procedure (TCLP) and the Gas Chromatography Test (GCT).[65]

Of the two tests mentioned the TCLP is more diverse. It is designed to determine both organic and inorganic compounds present in solid, liquid or multiphase wastes.[66] There are three possible outcomes of this test. Two of these results being that the test does not detect any listed hazardous waste materials which indicates either the lack of wastes or at such a low level that ordinary disposal is allowed. The other result being the detection of a listed hazardous waste.

Prior to running a full TCLP a bottle extractor test can be performed. This method of testing is mobile and can be run in the field. If the bottle extractor indicates a positive result for the suspected hazardous waste (in our case, lead), a full TCLP need not be run. However, a negative result by the bottle extractor does not necessarily mean the absence of lead and a full TCLP is required.[67] A chart on the following page explains in simple terms the TCLP process. It was reproduced from Appendix II of the 40 CFR.

The Gas Chromatography test is best used on sludges and soils. In the removal of lead paint this procedure has its

---

[65] Code of Federal Regulations [1989], Environmental Protection Agency, 40 CFR, Part 50.1, Washington D.C., U.S. Government Printing Office

[66] Code of Federal Regulations [1989], Environmental Protection Agency, 40 CFR, Part 261, Appendix II, Washington D.C., U.S. Government Printing Office, page 66

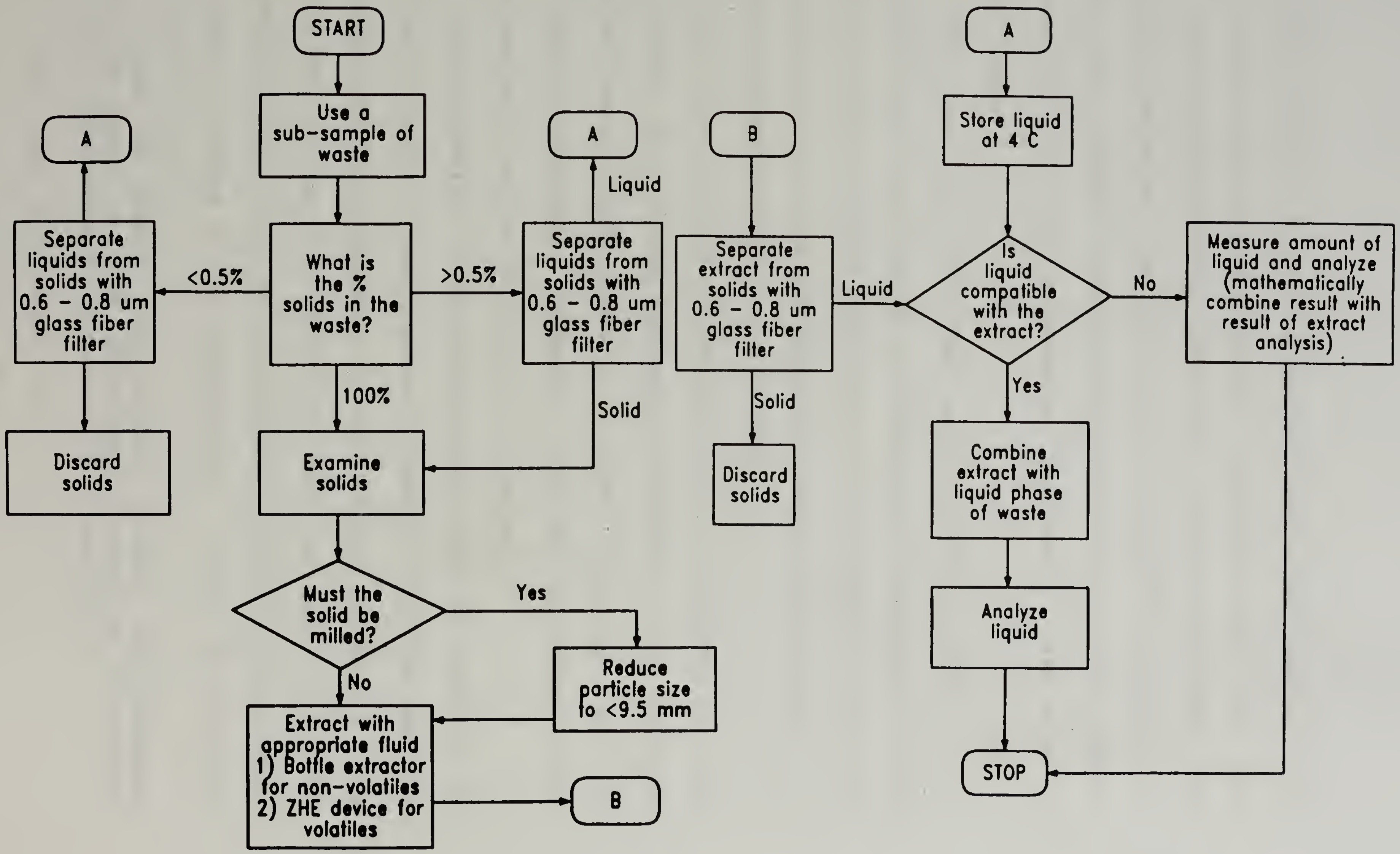
[67] Ibid

METHOD 1311

TOXICITY CHARACTERISTIC LEACHATE PROCEDURE

METHOD 1311 (CONTINUED)

TOXICITY CHARACTERISTIC LEACHATE PROCEDURE


START
Use a sub-sample of waste
What is the % solids in the waste?
<0.5%
>0.5%
100%
Separate liquids from solids with 0.6 - 0.8 um glass fiber filter
A
Discard solids
Separate liquids from solids with 0.6 - 0.8 um glass fiber filter
Liquid
A
Solid
Examine solids
Must the solid be milled?
Yes
Reduce particle size to <9.5 mm
No
Extract with appropriate fluid 1) Bottle extractor for non-volatiles 2) ZHE device for volatiles
B
B
Separate extract from solids with 0.6 - 0.8 um glass fiber filter
Solid
Discard solids
Liquid
A
Store liquid at 4 C
Is liquid compatible with the extract?
No
Measure amount of liquid and analyze (mathematically combine result with result of extract analysis)
Yes
Combine extract with liquid phase of waste
Analyze liquid
STOP

best applicability when chemical strippers are used or if a spill occurs contaminating the soil surrounding the work site. The test itself uses chemicals that are extremely toxic and great care must be taken during the process.[68] Selection of either test depends upon the characteristics of the sample, however the TCLP is the recommended procedure in the majority of the cases.

After testing of the lead paint indicating that it is a hazardous waste, setting up an appropriate containment system and collecting the waste by-product of the removal process the next step is preparing the hazardous waste for shipping to a proper hazardous waste disposal site.

Which ever party is responsible for disposal of lead paint waste must place the waste residue in EPA approved shipping containers.[69] These drums come in various sizes and are readily available. However, cost of the drums is not cheap and will add to the cost of clean-up.

After drumming, a proper manifest must be prepared for shipping to occur. Instructions on how to fill the manifest are contained in an appendix to Part 262 of the 40 CFR. The party appointed as the generator must designate which EPA approved facility (listed in Part 265 of the 40 CFR) to where the waste is going to be transported. Also, an alternate

---

[68] Code of Federal Regulations [1989], Environmental Protection Agency, 40 CFR, Part 261, Appendix X, Washington D.C., U.S. Government Printing Office, page 127

[69] Ibid, Part 265, page 234

hazardous waste disposal facility must be designated on the same manifest.[70]

Transportation and record keeping requirements are extensive and detailed and can be found in Parts 262.3 and 262.4 of the 40 CFR. The responsibility of these two areas is the generator. A generator as defined by the 40 CFR is the party that creates the hazardous substance. This can be interpreted as the remover of the lead paint or the owner of the structure from which the paint has been removed. Therefore, all parties involved in lead paint removal are subject to fines if proper procedures are not followed.

The 40 CFR also requires that all parties involved in any hazardous waste removal process have liability insurance covering any accident that might occur.[71] This is another added cost to the removal process.

Due to the complications of the 40 CFR combined with the 29 CFR it is highly recommended that prior to starting any type of lead paint abatement procedure that the expertise of an industrial hygienist be sought. Although the cost of their services is expensive, contracts can be worded that liability is shifted, if not totally, at least partially to the industrial hygienist. Use of this professional should not

---

[70] Code of Federal Regulations [1989], Environmental Protection Agency, 40 CFR, Part 262.2, Washington D.C., U.S. Government Printing Office, page 133

[71] Ibid, Part 264.147, page 157

relieve any party involved from a basic understanding of regulations involved.

Table 4. Summary of cost estimates for existing systems.

Technique	Containment/ Recovery ($/ft²)			Containment/Recovery and Paint Removal ($/ft²)		
	Low	Average	High	Low	Average	High
Ground/Water Covers	0.14	0.17	0.20	0.37	0.43	0.49
Water Screens	0.21	0.26	0.31	0.42	0.52	0.62
Blast Enclosures (Boston)	0.53	0.76	0.99	0.71	1.02	1.33
Blast Enclosures (California)	0.08	0.10	0.12	0.29	0.36	0.43
Blast Enclosures (Canada)	0.24	0.32	0.40	0.44	0.58	0.73
Vacuum Blasters				0.50	0.67	0.84
Water Curtains	0.10	0.13	0.16	0.31	0.39	0.47
Wet Blasters-Wet Sand				0.32	0.46	0.60
Wet Blasters-Water				0.55	0.78	1.01
Wet Blasters-Water/Air/Sand				0.41	0.69	0.99
Drapes-Barge	0.33	0.44	0.55	0.52	0.70	0.88
Drapes-Net	0.22	0.30	0.38	0.42	0.56	0.70

Source: Midwest Research Institute.

Table 5. Summary of cost estimates for existing systems not currently used on bridges.

Technique	Containment/Recovery and Paint Removal ($/ft²)		
	Low	Average	High
Vacuum-Shrouded Hand Tools	0.39	0.60	0.81
Centrifugal Blasters		> 0.10[a]	

Source: Midwest Research Institute.

[a] Estimates for road bed preparation not directly comparable to others.

Table 6. Summary of cost estimates for new systems.

Technique	Containment/Recovery and Paint Removal ($/ft²)		
	Low	Average	High
Cavitation Blasting	0.97	1.62	2.27
Flash Blasting	0.60	1.00	1.40
Strippable Coatings	2.40	4.00[a]	5.60

Source: Midwest Research Institute.

[a] Cost estimate for airplane preparation.

COST ESTIMATES FOR CONTAINMENT AND RECOVERY TECHNIQUES[72]

---

[72] Snyder, M.K. and Bendersky, D., "Removal of Lead Based Bridge Paints", National Cooperative Highway Research Program Report 265, Washington D.C., page 15

○ = Poor ⊖ = Fair ◒ = Good ● = Superior Ⓤ = Unknown

SYSTEM	EFFECTIVENESS			Paint Removal Rate	Adaptability	Cost*
	Air	Ground	Water			
1. Ground/Water Covers	○	⊖	⊖	◒	◒	◒
2. Ground/Water Covers with Improvements	⊖	◒	◒	◒	◒	◒
3. Water Screens	○	○	⊖	●	⊖	◒
4. Water Screens with Improvements	○	○	◒	●	⊖	◒
5. Blast Enclosures						
a. California System	⊖	⊖	⊖	◒	◒	●
b. Boston System	◒	◒	◒	◒	⊖	⊖
c. Boston System with Improvements	●	●	●	◒	⊖	⊖
d. Canadian System	●	●	●	●	◒	◒
e. Louisiana System	⊖	⊖	⊖	◒	◒	●
6. Vacuum Blasters	◒	◒	◒	○	◒	◒
7. Drapes	⊖	⊖	⊖	●	◒	◒
8. Water Curtains	⊖	○	○	◒	◒	●
9. Water Curtains with Improvements	⊖	⊖	⊖	●	◒	◒
10. Wet Blasters						
a. Wet Sandblasters	⊖	○	○	◒	●	●
b. Wet Sandblasters with Improvments	⊖	○	○	●	●	●
c. High Pressure Water	●	○	○	○	●	◒
d. High Pressure Water/Abrasive	◒	○	○	◒	●	●
e. Air/Water/Sand	◒	○	○	◒	●	◒
11. Centrifugal Blasters	◒	◒	◒	◒	Ⓤ	[a]
12. Vacuum-Shrouded Hand Tools	◒	◒	◒	⊖	●	◒
13. Cavitation Blasting (w. recovery)	●	●	●	⊖	◒	⊖[b]
14. Flash Blasting	⊖	⊖	⊖	○	○	⊖[b]
15. Strippable Coatings	●	◒	◒	Ⓤ	●	⊖[b]
16. Open Dry Abrasive Blasting	○	○	○	●	●	●

*From Tables 4 through 7.

[a] No cost information for preparation of steel surfaces; but cost of preparation of other surfaces is low.

[b] Systems have not been thoroughly tested on steel bridges; therefore, cost rating is from other steel surfaces

EVALUATION OF CONTAINMENT AND RECOVERY TECHNIQUES[73]

---

[73] Snyder, M.K. and Bendersky, D., "Removal of Lead-Based Bridge Paints", National Cooperative Highway Research Program Report 265, Washington D.C., page 14

CHAPTER 7

In both of the previous chapters the use of an industrial hygienist was strongly recommended. This was due to the complexity of both the 29 and 40 CFR. The Naval Facilities Engineering Command has prepared a guide specification for the removal of lead paint and it can be found in its' entirety in Appendix C. This guide specification includes the use of the industrial hygienist along with a comprehensive culmination of 29 and 40 CFR requirements.

In formulation of a contract the owner should review this document or similar instructions to ensure all necessary items are included in writing on the formal agreement. This guide specification does not include local or state requirements and those must be reviewed prior to formulating and signing a contract.

An example of how state requirements can add requirements to this specification is in the area of a Certified Industrial Hygienist (CIH). The only requirement by the EPA and listed within the guide specification is that the CIH is certified by the American Board of Industrial Hygiene in comprehensive practice.[74] However, the FDER requires that a CIH also be registered and certified within the State of Florida. This is

---

[74] Naval Facilities Engineering Command Guide Specification, Removal and Disposal of Lead-Contaminated Paint, Section 02090, 30 June 1991

to ensure that regulations and practices of the state are followed.[75]

A review of the CIH responsibilities indicates the importance of this individual in the lead paint removal process. The following are a list of those responsibilities in accordance with the guide specification:

1. Certify training
2. Review and approve a lead paint abatement plan in accordance with all applicable regulations
3. Inspect work for conformance with the plan
4. Direct monitoring
5. Inspect work for conformance with specifications
6. Ensure that personnel and the environment are protected from hazardous exposure at all times

As shown, the responsibilities of the CIH are extensive and carry vast liability if violations are found by the EPA or FDER. For these reasons the services of a CIH are not cheap. These individuals may account for 20% to 30% of the total cost of a project.[76]

This guide specification also requires submittals not only on the contractor's CIH but equipment to be used, removal and disposal plan, any applicable permits, testing laboratories and disposal facilities. From this requirement

---

[75] Conversation with Carolyn W. Salmon, Air Program Coordinator, Northwest District, FDER, 27 April 1993

[76] Average of recent Lead Paint Abatement Projects at NAS Pensacola Florida, 1990-1992

it is obvious that to approve such items the drafter of the document will also need the services of a CIH.

The NAVFAC guide specification is an excellent start for the formulation of a contract that includes lead paint abatement. However if used, it should be edited and modified to meet the specific project requirements along with the inclusion of local and state statutes plus any updates nationally.[77]

---

[77] Naval Facilities Engineering Command Guide Specification, "Removal and Disposal of Lead-Contaminated Paint", 30 June 1991, General Notes

CHAPTER 8

The preceding chapters have dealt with projects that encompassed large amounts or were entirely lead paint abatement. However, all projects that involve the disturbance of lead paint should take appropriate precautions for the protection of the environment, workers and other people.

One area of considerable concern is welding on surfaces that contain lead paint. Recent instances in Louisiana highlight the need for caution when welding. During bridge repairs which involved removal of plates and small members, two welders died of lead poisoning. The project did not call for the removal of paint from surfaces that were to be welded. Typical procedures are to weld the surface allowing the heat of the welding to blister the paint and thereby remove it. This practice releases lead in the welding gases which was inhaled by the welders. Although improper ventilation was also identified as a contributing factor, if the paint had been removed prior to the welding, two people would be alive today.[78]

A review of the most current National Institute for Occupational Safety and Health (NIOSH) indicates a lack of precaution in the area of surface paint removal prior to welding. NIOSH does mention lead as a possible hazardous

---

[78] Presentation on Lead-Paint Removal Practices presented by Naval Facilities Engineering Command, 1991

gaseous substance associated with welding but it is associated with the by-product of fluxes and not painted surfaces.[79] The combination of these sources creates a deadly scenario that should be addressed.

Welding is not the only area of concern. Projects that modify existing systems in buildings may have to disturb lead painted surfaces for completion. The use of electric saws to cut penetrations creates a fine dust that if inhaled could cause lead poisoning. Any form of chipping leaves lead paint fragments in a form that is transportable to the workers home or could contaminate the surrounding soil. Whatever the size of the job, proper precautions must be utilized to protect the worker and the surroundings. This does not mean total encapsulation for a small job but appropriate measures suitable to prevent contamination.

Although households are exempt from the regulations of the 40 CFR and the 29 CFR there should be some form of education to the modern do-it-yourselfer of the dangers associated with paint removal within a house. In the age of environmental awareness, the public would be very receptive to this information. As shown in by an example in the second chapter, the average homeowner is unaware of the dangers involved in removing lead paint. The family described in Chapter 2 new of lead poisoning from paint but believed it

---

[79] National Institute for Occupational Safety and Health, "Criteria for a Recommended Standard, Welding, Brazing and Thermal Cutting", Springfield VA, page 47

could only occur if chips were ingested. Inhalation from dust was not a concern.

CHAPTER 9

Poisoning of the blood system and contamination of the environment by the removal of lead paint is a serious but not an entirely new situation. The effects of blood poisoning from lead paint pealing from surfaces was known as early as the late 1800's. Protection of children, especially in low income housing areas was the main thrust of concern. However, recent interest has revolved around the construction industry and protection of workers and the environment.

As with asbestos, lead poisoning from the improper removal and disposal of lead paint has long lasting if not fatal effects. With this known however, specific guidance in the construction industry has been slow in formulation. The regulations cited from the 29 CFR, Occupational Safety and Health Administration, were created for industries that produce lead containing products. They have been interpreted by federal regulators to apply to lead paint removal. Interpretation could lead to either a lack of protection or requiring greater protection than necessary causing death or greater costs in an industry that already is experiencing escalating costs.

This lack of specific guidance for this form of work is also apparent in the environmental arena. The 40 CFR, Environmental Protection Agency, must interpret existing codes to fit this form of hazardous waste.

With time it is felt that specific guidance will become solidified as with asbestos removal. Already the military has created a guide specification for this type of work and it is felt that a suitable AIA document will be produced. Also, as with asbestos removal a new specialized field will be created within the construction arena. This will provide the general contractor and the owner a certified and responsible avenue to solve the lead abatement problem.

Until that time, the use of painters, general contractors or asbestos removal firms for lead paint removal are acceptable options. Be this as it may, the objective by all parties involved is safe and efficient work.

Currently there is no preferred method of removal and the selection is left to those involved. However, as regulations are presently written, if the paint is sufficiently adhered to a wood surface, the painted piece of wood if removed intact, can be disposed of at a typical construction disposal site. This is due to the method of the TCLP test described in Chapter Five. A proper sample includes the thickness of the wood, thereby assuring a result that is under the limits specified in the 40 CFR.[80] If total removal is contemplated on a wood sided structure, this would offer the most economical means of achievement.

---

[80] Conversation with Carolyn W. Salmon, Air Program Coordinator, Northwest District, Florida Department of Environmental Regulation, 27 April 1993

When total removal is the goal on metal or wood members that can be easily removed, other methods must be sought, each of those having advantages and disadvantages. The expense, time and safety concerns of complete abatement however makes partial removal and encapsulation a more attractive option. Removing only those areas that the paint is failing to adhere and then repainting the entire surface encapsulating the remaining lead paint. The biggest disadvantage to this is the need for continual maintenance after the project is complete. The owner must be vigilant to pealing paint with immediate correction when detected. Another disadvantage is that possible future regulations could cause the owner added costs by having a structure contaminated with lead paint.

This paper has presented medical concerns, various methods of removal, some associated costs and federal regulations that are involved with lead paint removal. Will this become the asbestos of the 1990's or will the construction industry lead the way in formulating safe and environmentally sound procedures. If promulgation of a national policy is left with the federal regulators it will be based on the asbestos policies. Currently however, the lack of a formal policy is in the construction industries favor. The military in recent projects has approached this problem with a common sense attitude. Provide environmental and human safety but at a basic level. In other words, use a proper amount of precaution but do not overkill.

As projects are completed with no contamination of the environment or blood poisoning occurrences, they will provide a basis for establishing a formal policy. These federal projects have been approved by the EPA a local environmental officials lending credence to the military approach.

As more lead abatement occurs and policy decisions are made it will become common knowledge on the best approach for a certain type of lead paint removal situation. Until that time the selection of a Certified Industrial Hygienist for the formulation of the lead removal plan that meets all requirements is essential. This will ensure worker and environmental protection along with ease of gaining EPA approval for permits.

APPENDIX A

APPENDIX A

LISTING OF COMPUTER PROGRAM

```
00001REMP20CHAIN RUNNH:J0003***
00010REMS141. DESCRIPTION
00012REMS01
00014REMS62   J0003 WILL ANALYZE THE COSTS OF THE ALTERNATIVE METHODS FOR
00016REMS01
00018REMS62   ELIMINATING THE LEAD PAINT HAZARD FROM A DWELLING UNIT. THE
00020REMS01
00022REMS60   PROGRAM PERMITS THE USER TO INPUT SPECIFIC INFORMATION ON
00024REMS01
00026REMS62   ANTICIPATED CONTRACT PACKAGES OF DWELLING UNITS.  THE LEAST-
00028REMS01
00030REMS61   COST COMBINATION OF ABATEMENT TECHNIQUES FOR EACH DWELLING
00032REMS01
00034REMS63   UNIT IS IDENTIFIED. DWELLING UNITS ARE GROUPED TOGETHER INTO
00036REMSO1
00038REMS63   CONTRACT PACKAGES SO THAT THE SUM OF THE EXPECTED BID PRICES
00040REMS01
00042REMS60   IS MINIMIZED. THE EXPECTED BID PRICE FOR EACH CONTRACT IS
00044REMS01
00046REMS60   GIVEN. EXPECTED CONTRACT COSTS FOR EACH DWELLING UNIT ARE
00048REMS01
00050REMS14   ALSO GIVEN.
00052REMS01
00054REMS142. LIMITATIONS
00056REMS01
00058REMS62   J0003 WILL HANDLE ANTICIPATED CONTRACT PACKAGES OF UP TO 10
00060REMSO1
00062REMS60   DWELLING UNITS. DATA FOR EACH DWELLING UNIT IS ENTERED IN
00064REMS01
00066REMS37   RESPONSE TO INQUIRIES AT RUN TIME.
00068REMSO1
00070REMS073. DATA
00072REMS01
00074REMS58   TWO TYPES OF DATA ARE INPUT, CONTRACT SPECIFIC DATA AND
00076REMS01
00078REMS63   DWELLING UNIT SPECIFIC DATA. INPUT DATA FOR EACH ANTICIPATED
00080REMSO1
00082REMS38   CONTRACT CONSISTS OF THE FOLLOWING:
00084REMS01
00086REMS27  A. CONTRACT SPECIFIC DATA
00088REMS01
00090REMS09     WAGE
00092REMS54                                             AVERAGE HOURLY
00094REMS51      CARPENTER                                WAGE RATE
00096REMS01
00098REMS48      PAINTER                                      "
```

```
00100REMS01
00102REMS48      PLASTERER                                  "
00104REMS01
00106REMS48      PAPER HANGER                               "
00108REMS01
00110REMS48      APPRENTICE CARPENTER                       "
00112REMS01
00114REMS48      LABORER                                    "
00116REMS01
00118REMS13     MATERIAL
00120REMS01
00122REMS63      GYPSUM WALLBOARD
00124REMS01                                       PRICE PER 4' x 8' SHEET
00126REMS54      PLYWOOD PANELING                           "
00128REMS01
00130REMS61      VINYL-COATED FABRIC
00132REMS01                                       PRICE PER SQUARE YARD
00134REMS56      LATEX FLAT WALL PAINT
00136REMS01                                       PRICE PER GALLON
00138REMS48      SEMI-GLOSS ENAMEL                          "
00140REMS18        (OIL BASE)
00142REMS01
00144REMS15     IF NEEDED:
00146REMS01
00148REMS58      UNFINISHED DOOR
00150REMS01                                       PRICE FOR ONE, NEW
00152REMS51      UNFINISHED DOOR FRAME                      "
00154REMS01
00156REMS59      UNFINISHED WINDOW AND FRAME
00158REMS01                                       PRICE FOR BOTH, NEW
00160REMS23   B. DWELLING UNIT DATA
00162REMS01
00164REMS51     GROSS SQ. FT. OF WALL AREA            SQUARE FEET
00166REMS01
00168REMS51     LINEAR FT. OF DOORS AND FRAMES        LINEAR FEET
00170REMS01
00172REMS46     LINEAR FT. OF WINDOWS & FRAMES              "
00174REMS01
00176REMS46     LINEAR FT. OF MISCELLANEOUS TRIM            "
00178REMS01
00180REMS61      OCCUPANCY
00182REMS63                          PERCENT OCCUPIED OR 1 IF OCCUPIED
00184REMS48     WAINSCOATING                             0 IF UNOCCUPIED
00186REMS01                          PERCENT OF WALL AREA
00188REMS43     SUBSTRATE CONDITION
00190REMS01                          PERCENT UNSOUND OR 1 IF POOR
00192REMS61     PANTRY WORK                              0 IF NOT
00194REMS58                          PERCENT NEEDING IT OR 1 IF NEEDED
00196REMS63     WALLPAPER ON WALLS                       0 IF NOT
00198REMS60                          PERCENT HAVING >2 LAYERS, 1 IF 3 OR
00200REMS48     IF NEEDED:                         MORE LAYERS 0 IF
                                                  NONE
```

```
00202REMS01
00204REMS36       NUMBER OF DOORS TO BE REPLACED
00206REMS01
00208REMS38        NUMBER OF DOOR FRAMES TO REPLACE
00210REMS01
00212REMS34       NUMBER OF WINDOWS AND FRAMES
00214REMS17        TO REPLACE
00216REMS01
00218REMS60       ADDRESS       DU/AGE CATEGORY         ADDRESS AS SPECIFIED
00220REMS01
00222REMS42       XRF READINGS  AVERAGE OR SEPARATE OR
00224REMS38                     FOR EACH TRIM TYPE
10000 FILES WAGE;MATL;AWR
10005 DIM D(10,10),F(10,10),L(10,10),P(10,10)
10010 DIM W(10,10),Y(10,10),Z(5,10),X(45,3)
10015 DIM Z$(10),P$(10),Y$(10),Q$(10)
10020 REM READ NAMES OF WALL TECHNIQUES INTO VARIABLES
10025 READ A$,B$,C$,D$,E$,F$
10030 DATA GYPSUM WALLBOARD,PLYWOOD PANELING,CEMENTITIOUS COATING
10035 DATA VENEER PLASTER    ,VINYL-COATED FABRIC,CEMENT-COATED FIBERGLASS
10040 REM READ NAMES OF TRIM TECHNIQUES INTO VARIABLES
10045 READ G$,H$,I$,J$
10050 DATA INFRA-RED DEVICE,SOLVENT STRIP    ,ELECTRIC HEAT GUN
10055 DATA HAND SCRAPING    ,
10060 MAT READ F(7,6)
10065 DATA 0.6,0,0,0,0.4,0,0.82,0,0,0,0.18,0,0.24,0.6,0,0,0.16,0
10070 DATA 0.20,0.39,0.29,0,0,0.12,0.26,0.26,0,0.48,0,0
10075 DATA 0.50,0.14,0,0.36,0,0,0,0,0,0,0.5,0.5
10080 READ K$,L$
10085 DATA NONE            ,COMPONENT REPLACEMENT ONLY
10090 REM WAGE RATES STORED AS W(I,1) FOR MATRIX MULTIPLICATION
10095 PRINT "WAGE RATE INFORMATION"
10100 PRINT
10105 MAT W=ZER(6,1)
10110 PRINT "INPUT WAGE RATE PER HOUR FOR CARPENTER"
10115 INPUT W(1,1)
10120 PRINT "INPUT WAGE RATE PER HOUR FOR PAINTER"
10125 INPUT W(2,1)
10130 PRINT "INPUT WAGE RATE PER HOUR FOR PLASTERER"
10135 INPUT W(3,1)
10140 PRINT "INPUT WAGE RATE PER HOUR FOR PAPERHANGER"
10145 INPUT W(4,1)
10150 PRINT "INPUT WAGE RATE PER HOUR FOR APPRENTICE CARPENTER"
10155 INPUT W(5,1)
10160 PRINT "INPUT WAGE RATE PER HOUR FOR LABORER"
10165 INPUT W(6,1)
10170 MAT L=ZER(7,1)
10175 MAT L=F*W
10180 SCRATCH #1
10185 SCRATCH #3
10190 MAT WRITE #1,W
```

```
10195 MAT WRITE #3,L
10200 REM MATERIAL PRICES STORED AS M(I)
10205 PRINT
10210 PRINT
10215 PRINT "MATERIAL PRICE INFORMATION"
10220 PRINT
10225 SCRATCH #2
10230 PRINT "INPUT PRICE OF 4 FT BY 8 FT SHEET OF GYPSUM WALLBOARD"
10235 INPUT M(1)
10240 PRINT "INPUT PRICE OF 4 FT BY 8 FT SHEET OF PLYWOOD PANELING"
10245 INPUT M(2)
10250 PRINT "INPUT PRICE PER SQUARE YARD OF VINYL-COATED FABRIC"
10255 INPUT M(3)
10260 PRINT "INPUT PRICE PER GALLON OF LATEX FLAT WALL PAINT"
10265 INPUT M(4)
10270 PRINT "INPUT PRICE PER GALLON OF SEMI-GLOSS ENAMEL (OIL BASE)"
10275 INPUT M(5)
10280 FOR L=1 TO 5
10285 WRITE #2,M(L)
10290 NEXT L
10295 PRINT "TYPE 1 IF THERE ARE ANY DOORS, DOOR FRAMES OR WINDOWS"
10300 PRINT "AND FRAMES THAT NEED TO BE REPLACED, 0 IF NOT"
10305 INPUT Q
10310 IF Q=0 THEN 10345
10315 PRINT "INPUT PRICE OF NEW, UNFINISHED DOOR"
10320 INPUT M(6)
10325 PRINT "INPUT PRICE OF NEW, UNFINISHED DOOR FRAME"
10330 INPUT M(7)
10335 PRINT "INPUT PRICE OF NEW, UNFINISHED WINDOW AND FRAME"
10340 INPUT M(8)
10345 PRINT
10350 REM COMPUTE AVERAGE WAGE RATES FOR EACH WALL TECHNIQUE AND FOR TRIM
10355 PRINT "IF PROGRAM COST ESTIMATES ARE DESIRED, TYPE 1, IF"
10360 PRINT "CONTRACT COST ESTIMATES ARE DESIRED, TYPE 0"
10365 INPUT P
10370 IF P=1 THEN 10395
10375 PRINT "INPUT NUMBER OF DWELLING UNITS TO BE DONE (MUST BE <= 10)"
10380 INPUT N
10385 LET N9=N
10390 GO TO 10400
10395 LET N=1
10400 PRINT
10405 PRINT "STOP FOR A MINUTE AND CHECK THE DATA YOU HAVE JUST INPUT"
10410 PRINT "IF ANY ERROR WAS MADE IN ENTERING IT, YOU MAY TYPE 1"
10415 PRINT "TO REPEAT INPUT STATEMENTS; IF NOT, TYPE 0 TO CONTINUE"
10420 INPUT Z
10425 IF Q7<>1 THEN 10435
10430 IF Z=1 THEN 10295
10435 IF Z=1 THEN 10095
10440 REM N2 IS NUMBER OF CONTRACTS, N3 IS NUMBER OF PAIRS
10445 IF INT(N/2)=N/2 THEN 10465
```

```
10450 LET N2=(N+1)/2
10455 LET N3=N2-1
10460 GO TO 10475
10465 LET N2=N/2
10470 LET N3=N2
10475 MAT F=ZER(N,10)
10480 REM INPUT DU INFORMATION THAT MUST BE STORED FOR COMPUTING
10485 REM MARKUP AND BID PRICE
10490 FOR J=1 TO N
10495 IF P=0 THEN 10510
10500 PRINT "                DWELLING UNIT INFORMATION"
10505 GO TO 10525
10510 PRINT
10515 PRINT
10520 PRINT "                DWELLING UNIT NUMBER"J
10525 PRINT
10530 PRINT "TYPE IN AN IDENTIFYING ADDRESS OR DU TYPE FOR THIS DWELLING UNIT"
10535 INPUT Q$(J)
10540 IF P=0 THEN 10560
10545 PRINT "FOR POLICY ESTIMATES INPUT AVERAGES FOR SQUARE FEET, LINEAR FEET,"
10550 PRINT "XRF, ETC.; AND PERCENTAGE OF SAMPLE NEEDED FOR THOSE VARIABLES"
10555 PRINT "REQUIRING A 1 OR 0"
10560 PRINT "INPUT GROSS SQUARE FEET OF WALL AREA"
10565 INPUT D(1,J)
10570 REM D(2,J) IS NET SQUARE FEET OF WALL AREA
10575 IF D(1,J)<400 THEN 10590
10580 LET D(2,J)=77+0.64*D(1,J)
10585 GO TO 10595
10590 LET D(2,J)=0.83*D(1,J)
10595 PRINT "INPUT LINEAR FEET OF DOORS PLUS LINEAR FEET OF DOOR"
10600 PRINT "FRAMES REQUIRING PAINT REMOVAL"
10605 INPUT D(3,J)
10610 REM D8 IS NUMBER OF DOORS AND FRAMES TO BE DELEADED
10615 LET D8=D(3,J)/8
10620 PRINT "INPUT LINEAR FEET OF WINDOWS PLUS LINEAR FEET OF"
10625 PRINT "WINDOW FRAMES REQUIRING PAINT REMOVAL"
10630 INPUT D(4,J)
10635 REM D7 IS NUMBER OF WINDOWS AND FRAMES TO BE DELEADED
10640 LET D7=D(4,J)/7
10645 PRINT "INPUT LINEAR FEET OF MISCELLANEOUS TRIM REQUIRING'
10650 PRINT "PAINT REMOVAL"
10655 INPUT D(5,J)
10660 LET D(7,J)=D(3,J)+D(4,J)+D(5,J)
10665 PRINT "TYPE 1 IF UNIT IS OCCUPIED, 0 IF NOT"
10670 INPUT D(6,J)
10675 REM INPUT OTHER DU RELATED DATA NECESSARY FOR CALCULATIONS
10680 IF D(1,J)=0 THEN 10735
10685 PRINT "INPUT PERCENT OF WALL AREA THAT IS WAINSCOATED"
10690 PRINT "(TYPE AS A DECIMAL, E.G., 0.25 FOR 25 PERCENT)"
10695 INPUT E(3)
10700 PRINT "TYPE 1 IF SUBSTRATE CONDITION IS POOR, 0 IF NOT"
```

```
10705 INPUT E(4)
10710 PRINT "TYPE 1 IF PANTRY WORK IS NECESSARY, 0 IF NOT"
10715 INPUT E(5)
10720 PRINT "TYPE 1 IF 3 OR MORE LAYERS OF WALLPAPER ARE ON WALLS,"
10725 PRINT "0 IF NOT"
10730 INPUT E(6)
10735 IF Q=0 THEN 10770
10740 PRINT "INPUT NUMBER OF DOORS TO BE REPLACED"
10745 INPUT E(7)
10750 PRINT "INPUT NUMBER OF DOOR FRAMES TO BE REPLACED"
10755 INPUT E(8)
10760 PRINT "INPUT NUMBER OF WINDOWS & FRAMES TO BE REPLACED"
10765 INPUT E(9)
10770 IF D(1,J)<>0 THEN 10810
10775 LET Z1=0
10780 LET C8=0
10785 LET C9=0
10790 LET B8=0
10795 LET B9=0
10800 LET B(1)=0
10805 GO TO 10815
10810 LET Z1=9
10815 IF D(7,J)=0 THEN 10905
10820 PRINT "TYPE 1 IF SEPARATE XRF READINGS ARE AVAILABLE FOR DOORS,"
10825 PRINT "WINDOWS AND MISCELLANEOUS TRIM, 0 IF ONLY AN AVERAGE"
10830 PRINT "IS AVAILABLE"
10835 INPUT Y
10840 IF Y=1 THEN 10875
10845 PRINT "INPUT AVERAGE XRF READING"
10850 INPUT X
10855 LET X1=X
10860 LET X2=X
10865 LET X3=X
10870 GO TO 10905
10875 PRINT "INPUT XRF READING FOR DOORS AND DOOR FRAMES"
10880 INPUT X1
10885 PRINT "INPUT XRF READING FOR WINDOWS AND FRAMES"
10890 INPUT X2
10895 PRINT "INPUT XRF READING FOR MISCELLANEOUS TRIM"
10900 INPUT X3
10905 PRINT "STOP AND CHECK THE DATA FOR THIS DWELLING UNIT"
10910 PRINT "IF THERE IS AN ERROR, TYPE 1 TO REPEAT INPUT STATEMENTS"
10915 PRINT "IF NOT, TYPE 0"
10920 INPUT Z
10925 IF Z=1 THEN 10520
10930 REM COMPUTE PAINTING COST FOR WALLS AND CEILINGS
10935 IF Z1=0 THEN 11025
10940 LET C8=1.35*(D(1,J)/39.95)↑2
10945 LET C9=D(1,J)+C8
10950 REM B8 IS PAINTING COST FOR ALL TECHNIQUES BUT GYP AND VENEER PLASTER
10955 LET B8=-0.000296*C8+0.0106*W(2,1)+0.0257*M(4)+0.1736*D(2,J)/D(1,J)
```

```
10960 IF B8>=0.08 THEN 10970
10965 LET B8=0.08
10970 REM B9 IS PAINTING COST FOR GYP AND VENEER PLASTER
10975 LET B9=-0.000296*C9+0.0106*W(2,1)+0.0257*M(4)+0.1736*D(2,J)/D(1,J)
10980 IF B9>=0.08 THEN 10990
10985 LET B9=0.08
10990 LET B(1)=-1.7700+306.5874/D(2,J)+0.0620*L(1,1)
10995 LET B=0.5009*M(1)+0.2740*E(5)
11000 REM GYPSUM WALLBOARD
11005 LET B(1)=B(1)+B
11010 IF B(1)>=0.25 THEN 11020
11015 LET B(1)=0.25
11020 LET B(1)=B(1)*D(1,J)+B9*C9
11025 LET C(J)=B(1)
11030 LET G(J)=B(1)
11035 LET Z$(J)=A$
11040 LET P$(J)=A$
11045 IF Z1<>0 THEN 11080
11050 LET Z$(J)=K$
11055 FOR K=2 TO 6
11060 LET B(K)=0
11065 NEXT K
11070 GO TO 11340
11075 REM PLYWOOD PANELING
11080 LET A(2)=0.07995*M(2)-0.0231*L(2,1)+0.0829*E(4)
11085 LET B(2)=-0.3245+0.00054*D(2,J)+0.0748*L(2,1)+1.2602*A(2)
11090 IF B(2)>=0.77 THEN 11100
11095 LET B(2)=0.77
11100 LET B(2)=B(2)*D(1,J)+B8*C8
11105 IF C(J)<=B(2) THEN 11130
11110 LET C(J)=B(2)
11115 LET G(J)=B(2)
11120 LET Z$(J)=B$
11125 LET P$(J)=B$
11130 REM CEMENTITIOUS COATING
11135 LET A(3)=-0.5002+0.6872*D(2,J)/D(1,J)+0.1037+0.1741*E(4)
11140 LET B(3)=-0.8817-0.0004*D(1,J)+0.1154*L(3,1)+3.8636*A(3)+0.1416*E(6)
11145 IF B(3)>=0.22 THEN 11155
11150 LET B(3)=0.22
11155 LET B(3)=B(3)*D(1,J)+B8*C8
11160 IF C(J)<=B(3) THEN 11175
11165 LET C(J)=B(3)
11170 LET Z$(J)=C$
11175 REM VENEER PLASTER
11180 LET A(4)=A(3)-0.0847
11185 LET B(4)=0.8817-0.0004*D(1,J)+0.1154*L(4,1)+3.8636*A(4)+0.1416*E(6)+0.206
11190 IF B(4)>=0.35 THEN 11200
11195 LET B(4)=0.35
11200 LET B(4)=B(4)*D(1,J)+B9*C9
11205 IF C(J)<=B(4) THEN 11220
11210 LET C(J)=B(4)
```

```
11215 LET Z$(J)=D$
11220 REM VINYL-COATED FABRIC
11225 LET R(5)=-25.2456+0.0276*D(2,J)+22.0745*D(2,J)/D(1,J)
11230 LET R=1.2933*L(5,1)-24.8364*E(3)
11235 LET R(5)=R(5)+R
11240 LET A(5)=0.0958*M(2)+0.5447*E(3)
11245 LET B(5)=L(5,1)/R(5)+A(5)
11250 IF B(5)>=0.84 THEN 11260
11255 LET B(5)=0.84
11260 LET B(5)=B(5)*D(1,J)+B8*C8
11265 IF C(J)<=B(5) THEN 11280
11270 LET C(J)=B(5)
11275 LET Z$(J)=E$
11280 REM CEMENT-COATED FIBERGLASS
11285 LET R(6)=43.5809-33.6107*D(2,J)/D(1,J)-45.5105*E(3)
11290 LET R=-3.4202*E(4)+8.1578
11295 LET R(6)=R(6)+R
11300 LET A(6)=0.5600*D(2,J)/D(1,J)+1.0900*L(6,1)/R(6)
11305 LET B(6)=L(6,1)/R(6)+A(6)
11310 IF B(6)>=0.66 THEN 11320
11315 LET B(6)=0.66
11320 LET B(6)=B(6)*D(1,J)+B8*C8
11325 IF C(J)<=B(6) THEN 11340
11330 LET C(J)=B(6)
11335 LET Z$(J)=F$
11340 REM FIND XRF TIMES LINEAR FEET FOR TRIM
11345 LET Y1=X1*D(3,J)
11350 LET Y2=X2*D(4,J)
11355 LET Y3=X3*D(5,J)
11360 REM FIND MINIMUM DIRECT COST TECHNIQUE FOR TRIM
11365 REM S(I)=DOORS T(I)=WINDOWS U(I)=TRIM V(I)=TOTAL
11370 REM INFRA-RED HEATING DEVICE
11375 IF D(6,J)=1 THEN 11445
11380 LET S(1)=(0.2903*L(7,1)-0.0007*Y1)/0.92
11385 IF S(1)>=1.05 THEN 11395
11390 LET S(1)=1.05
11395 LET T(1)=(0.2903*L(7,1)-0.0007*Y2)/0.89
11400 IF T(1)>=1.05 THEN 11410
11405 LET T(1)=1.05
11410 LET U(1)=(0.1354*L(7,1)-0.4913)/0.80
11415 IF U(1)>=0.29 THEN 11425
11420 LET U(1)=0.29
11425 LET V(1)=S(1)*D(3,J)+T(1)*D(4,J)+U(1)*D(5,J)
11430 LET H(J)=V(1)
11435 LET Y$(J)=G$
11440 GO TO 11455
11445 LET H(J)=100000
11450 LET V(1)=0
11455 REM SOLVENT-BASED PAINT REMOVER
11460 LET S(2)=(-1.3499+0.5727*L(7,1)-0.0013*Y1)/0.88
11465 IF S(2)>=1.25 THEN 11475
```

```
11470 LET S(2)=1.25
11475 LET T(2)=(-1.3499+0.5727*L(7,1)-0.0013*Y2)/0.88
11480 IF T(2)>=1.25 THEN 11490
11485 LET T(2)=1.25
11490 LET U(2)=0.1354*L(7,1)/0.82
11495 IF U(2)>=0.51 THEN 11505
11500 LET U(2)=0.51
11505 LET V(2)=S(2)*D(3,J)+T(2)*D(4,J)+U(2)*D(5,J)
11510 IF H(J)<=V(2) THEN 11525
11515 LET H(J)=V(2)
11520 LET Y$(J)=H$
11525 REM ELECTRIC HEAT GUN
11530 LET S(3)=0.2775*L(7,1)-0.00861*D(3,J)+0.1769
11535 IF S(3)>=0.58 THEN 11545
11540 LET S(3)=0.58
11545 LET T(3)=0.2775*L(7,1)-0.00861*D(4,J)+0.4735
11550 IF T(3)>=0.58 THEN 11560
11555 LET T(3)=0.58
11560 LET U(3)=0.1372*L(7,1)-0.0073*D(5,J)+0.1406
11565 IF U(3)>=0.17 THEN 11575
11570 LET U(3)=0.17
11575 LET V(3)=S(3)*D(3,J)+T(3)*D(4,J)+U(3)*D(5,J)
11580 IF H(J)<=V(3) THEN 11595
11585 LET H(J)=V(3)
11590 LET Y$(J)=I$
11595 REM HAND SCRAPING
11600 LET S(4)=0.9468-0.0213*D(3,J)+0.3262*L(7,1)
11605 IF S(4)>=1.16 THEN 11615
11610 LET S(4)=1.16
11615 LET T(4)=0.9468-0.0213*D(4,J)+0.3262*L(7,1)
11620 IF T(4)>=1.16 THEN 11630
11625 LET T(4)=1.16
11630 LET U(4)=0.1146*L(7,1)
11635 IF U(4)>=0.45 THEN 11645
11640 LET U(4)=0.45
11645 LET V(4)=S(4)*D(3,J)+T(4)*D(4,J)+U(4)*D(5,J)
11650 IF H(J)<=V(4) THEN 11665
11655 LET H(J)=V(4)
11660 LET Y$(J)=V$
11665 REM PAINTING COSTS FOR TRIM
11670 LET S(9)=(0.7517*W(2,1)+0.9343*M(5)-0.8776*D8)*D8
11675 LET T(9)=(2.5942*W(2,1)+1.5865*M(5)-3.8199*D7)*D7
11680 LET U(9)=(0.0388*W(2,1)*D(5,J)
11685 LET V(9)=S(9)+T(9)+U(9)
11690 REM V(9) IS TOTAL COST FOR PAINTING TRIM-ALL TECHNIQUES
11695 IF V(9)>=0.09*D(7,J) THEN 11705
11700 LET V(9)=0.09*D(7,J)
11705 REM COMPONENT REPLACEMENT COST
11710 LET S(8)=(0.7517*W(2,1)+0.9343*M(5)-0.8776*E(7))*E(7)*0.7
11715 LET T(8)=(0.7517*W(2,1)+0.9343*M(5)-0.8776*E(8))*E(8)*0.7
11720 LET U(8)=(2.5942*W(2,1)+1.5865*M(5)-3.8199*E(9))*E(9)
```

```
11725 LET V(8)=S(8)+T(8)+U(8)
11730 LET V(5)=E(7)*(95.2023-4.5476*L(1,1)+0.7604*M(6))
11735 LET V(5)=V(5)+E(8)*(5.702*L(1,1)+1.699*M(7))
11740 LET V(5)=V(5)+E(9)*(6.740*L(1,1)+1.1016*M(8)+25.213)
11745 LET V(5)=Q*(V(5)+V(8))
11750 LET H(J)=H(J)+V(9)+V(5)
11755 FOR M=1 TO 4
11760 LET V(M)=V(M)+V(9)
11765 NEXT M
11770 IF H(J)=0 THEN 11790
11775 IF D(7,J)<>0 THEN 11795
11780 LET Y$(J)=L$
11785 GO TO 11795
11790 LET Y$(J)=K$
11795 IF P<>1 THEN 11935
11800 LET B(7)=(B(1)+B(2)+B(3)+B(4)+B(5)+B(6))/6
11805 IF V(1)=0 THEN 11820
11810 LET V(6)=(V(1)+V(2)+V(2)+V(3)+V(4))/4+V(5)
11815 GO TO 11825
11820 LET V(6)=(V(2)+V(3)+V(4))/3+V(5)
11825 LET P2=1.16-0.0003*D(2,J)+0.0015*D(7,J)
11830 IF P2<1.1 THEN 11850
11835 IF P2<1.5 THEN 11855
11840 LET P2=1.5
11845 GO TO 11855
11850 LET P2=1.1
11855 LET P3=P2*B(7)
11860 LET P4=P2*V(6)
11865 PRINT
11870 LET P5=P3+P4
11875 PRINT
11880 PRINT USING 11885,Q$(1)
11885:'CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
11890 PRINT
11895 PRINT "WALL COST","TRIM COST","TOTAL COST","MARKUP RATIO"
11900 PRINT P3,P4,P5,P2
11905 PRINT
11910 PRINT
11915 PRINT "IF YOU WISH TO DO MORE COST ESTIMATES TYPE 1, IF NOT TYPE 0"
11920 INPUT P6
11925 IF P6=1 THEN 10355
11930 GO TO 13300
11935 REM F IS BASIC DATA MATRIX
11940 LET F(J,1)=C(J)+H(J)
11945 LET F(J,2)=D(2,J)
11950 LET F(J,3)=D(7,J)
11955 IF Z$(J)=P$(J) THEN 11970
11960 LET F(J,4)=0
11965 GO TO 11975
11970 LET F(J,4)=D(2,J)
11975 LET F(J,5)=C(J)
```

```
11980 LET F(J,6)=G(J)
11985 LET F(J,7)=G(J)-C(J)
11990 NEXT J
11995 LET F1=0
12000 AT Y=ZER(N,10)
12005 MAT Y=F
12010 IF N<>1 THEN 12025
12015 LET Y(1,8)=1
12020 GO TO 12490
12025 REM PAIR DWELLING UNITS
12030 REM L IS DIFFERENTIAL MARKUP MATRIX
12035 MAT L=ZER(N,N)
12040 FOR I=1 TO N
12045 FOR K=1 TO N
12050 IF Y(I,2)<>0 THEN 12070
12055 IF Y(K,2)<>0 THEN 12070
12060 LET L(I,K)=10
12065 GO TO 12075
12070 LET L(I,K)=-0.00079*Y(I,2)+0.00052*Y(I,3)-0.2144*(Y(I,4)/(Y(I,2)+Y(K,2)))
12075 NEXT K
12080 NEXT I
12085 FOR I=1 TO N
12090 LET L(I,I)=9
12095 NEXT I
12100 REM P IS DIRECT COST MATRIX
12105 MAT P=ZER(N,N)
12110 FOR J=1 TO N
12115 LET P(J,J)=Y(J,1)
12120 NEXT J
12125 REM D IS TEST MATRIX
12130 MAT D=ZER(N,N)
12135 MAT D=L*P
12140 REM W IS TRIANGULAR TEST MATRIX
12145 MAT W=ZER(N,N)
12150 FOR K=1 TO N-1
12155 LET I=K+1
12160 LET W(I,K)=D(I,K)+D(K,I)
12165 LET I=I+1
12170 IF I<N THEN 12160
12175 NEXT K
12180 LET N1=N*(N-1)/2
12185 MAT X=ZER(N1,3)
12190 LET J=1
12195 FOR K=1 TO N-1
12200 LET I=K+1
12205 LET X(J,1)=W(I,K)
12210 LET X(J,2)=I
12215 LET X(J,3)=K
12220 IF J>=N1 THEN 12250
12225 LET I=I+1
12230 LET J=J+1
```

```
12235 IF I>N THEN 12245
12240 GO TO 12205
12245 NEXT K
12250 REM SORT X MATRIX
12255 FOR L=1 TO N1-1
12260 FOR M=1 TO N1-1
12265 LET Q1=X(M,1)
12270 LET Q2=X(M+1,1)
12275 LET R1=X(M,2)
12280 LET R2=X(M+1,2)
12285 LET S1=X(M,3)
12290 LET S2=X(M+1,3)
12295 IF Q1<=Q2 THEN 12330
12300 LET X(M,1)=Q2
12305 LET X(M+1,1)=Q1
12310 LET X(M,2)=R2
12315 LET X(M+1,2)=R1
12320 LET X(M,3)=S2
12325 LET X(M+1,3)=S1
12330 NEXT M
12335 NEXT L
12340 IF F1=1 THEN 12545
12345 REM Y IS PRELIMINARY CONTRACT PACKAGE MATRIX
12350 LET J=1
12355 LET K=1
12360 LET B2=X(J,2)
12365 LET B3=X(J,3)
12370 IF F(B2,10)=1 THEN 12430
12375 IF F(B3,10)=1 THEN 12430
12380 FOR M=1 TO 7
12385 LET Y(K,M)=F(B2,M)+F(B3,M)
12390 NEXT M
12395 LET Y(K,8)=B2
12400 LET Y(K,9)=B3
12405 LET F(B2,10)=1
12410 LET F(B3,10)=1
12415 IF K=N2 THEN 12490
12420 IF K=N3 THEN 12440
12425 LET K=K+1
12430 LET J=J+1
12435 GO TO 12360
12440 LET K=K+1
12445 FOR I=1 TO N
12450 IF F(I,10)=0 THEN 12460
12455 NEXT I
12460 LET B2=I
12465 FOR M=1 TO 7
12470 LET Y(K,M)=F(B2,M)
12475 NEXT M
12480 LET Y(K,8)=B2
12485 LET Y(K,9)=0
```

```
12490 IF N>2 THEN 12530
12495 LET N6=1
12500 FOR M=1 TO 7
12505 LET Z(1,M)=Y(1,M)
12510 NEXT M
12515 LET Z(1,8)=1
12520 LET Z(1,9)=0
12525 GO TO 12935
12530 LET F1=1
12535 LET N=K
12540 GO TO 12025
12545 REM Z IS FINAL CONTRACT PACKAGE MATRIX
12550 LET J=1
12555 LET K=1
12560 IF INT(N/2)=N/2 THEN 12580
12565 LET N4=(N+1)/2
12570 LET N5=N4-1
12575  GO TO 12590
12580 LET N4=N/2
12585 LET N5=N4
12590 FOR J=1 TO (N-1)*N/2
12595 IF X(J,1)>0 THEN 12685
12600 LET B2=X(J,2)
12605 LET B3=X(J,3)
12610 IF Y(B2,10)=1 THEN 12670
12615 IF Y(B3,10)=1 THEN 12670
12620 FOR M=1 TO 7
12625 LET Z(K,M)=Y(B2,M)+Y(B3,M)
12630 NEXT M
12635 LET Z(K,8)=B2
12640 LET Z(K,9)=B3
12645 LET Y(B2,10)=1
12650 LET Y(B3,10)=1
12655 IF K=N4 THEN 12930
12660 IF K=N5 THEN 12680
12665 LET K=K+1
12670 NEXT J
12675 GO TO 12685
12680 LET K=K+1
12685 IF N2=N3 THEN 12805
12690 FOR I=1 TO N
12695 IF Y(I,9)=0 THEN 12705
12700 NEXT I
12705 IF Y(I,10)=1 THEN 12790
12710 LET B2=I
12715 LET N1=N*(N-1)/2
12720 FOR I=1 TO N1
12725 IF X(I,2)=B2 THEN 12740
12730 IF X(I,3)=B2 THEN 12750
12735 NEXT I
12740 LET B3=X(I,3)
```

```
12745 GO TO 12755
12750 LET B3=X(I,2)
12755 IF Y (B3,10)=1 THEN 12880
12760 FOR M=1 TO 7
12765 LET Z(K,M)=Y(B2,M)+Y(B3,M)
12770 NEXT M
12775 LET Z(K,8)=B3
12780 LET Z(K,9)=B2
12785 LET Y(B2,10)=1
12790 LET Y(B3,10)=1
12795 IF K=N4 THEN 12805
12800 LET K=K+1
12805 FOR I=1 TO N
12810 IF Y(I,10)=1 THEN 12870
12815 FOR M=1 TO 7
12820 LET Z(K,M)=Y(I,M)
12825 NEXT M
12830 LET Z(K,8)=I
12835 LET Z(K,9)=0
12840 LET Y(I,10)=1
12845 FOR L=1 TO N
12850 IF Y(L,10)=0 THEN 12865
12855 NEXT L
12860 GO TO 12875
12865 LET K=K+1
12870 NEXT I
12875 GO TO 12930
12880 FOR I=1 TO N
12885 IF Z(I,8)=B3 THEN 12900
12890 IF Z(I,9)=B3 THEN 12900
12895 NEXT I
12900 LET Z(I,10)=B2
12905 FOR M=1 TO 7
12910 LET Z(I,M)=Z(I,M)+Y(B2,M)
12915 NEXT M
12920 LET Y(B2,10)=1
12925 GO TO 12805
12930 LET N6=K
12935 MAT W=ZER(N6,5)
12940 FOR K=1 TO N6
12945 LET Z8=Z(K,8)
12950 LET W(K,1)=Y(Z8,8)
12955 LET W(K,2)=Y(Z8,9)
12960 IF Z(K,9)=0 THEN 12995
12965 LET Z9=Z(K,9)
12970 LET W(K,3)=Y(Z9,8)
12975 LET W(K,4)=Y(Z9,9)
12980 LET Z9=Z(K,10)
12985 IF Z9=0 THEN 12995
12990 LET W(K,5)=Y(Z9,8)
12995 NEXT K
```

```
13000 FOR K=1 TO N6
13005 PRINT
13010 PRINT
13015 PRINT "                              CONTRACT "K
13020 PRINT
13025 LET I=1
13030 LET M(K)=-0.000079*Z(K,2)+0.00052*Z(K,3)-0.2144*(Z(K,4)/Z(K,2))
13035 LET M(K)=M(K)+1.2972
13040 REM W5 IS DWELLING UNIT NUMBER
13045 LET W5=W(K,I)
13050 IF W5<>0 THEN 13075
13055 LET I=I+1
13060 IF I>5 THEN 13165
13065 IF W(K,I)=0 THEN 13165
13070 LET W5=W(K,I)
13075 IF F(W5,2)=0 THEN 13120
13080 LET M9=-0.2144*(F(W5,4))/Z(K,2)
13085 LET M8=M9*Z(K,1)+M(K)*F(W5,7)
13090 IF M8>=0 THEN 13120
13095 LET M(K)=M(K)+M9
13100 LET Z$(W5)=P$(W5)
13105 LET F(W5,1)=F(W5,1)+F(W5,7)
13110 LET Z(K,1)=Z(K,1)+F(W5,7)
13115 LET Z(K,4)=Z(K,4)+F(W5,4)
13120 PRINT " DWELLING UNIT  "W5,Q$(W5)
13125 PRINT
13130 PRINT "      WALL TECHNIQUE     "Z$(W5)
13135 PRINT "     TRIM TECHNIQUE     "Y$(W5)
13140 PRINT "             DIRECT COST  $"F(W5,1)
13145 PRINT
13150 IF W5=0 THEN 13165
13155 LET I=I+1
13160 IF I<=5 THEN 13045
13165 IF M(K)<1.1 THEN 13185
13170 IF M(K)<=1.5 THEN 13190
13175 LET M(K)=1.5
13180 GO TO 13190
13185 LET M(K)=1.1
13190 LET Z(K,1)=M(K)*Z(K,1)
13195 PRINT "                         CONTRACT PRICE    $"Z(K,1)
13200 PRINT "                           MARKUP RATIO       "M(K)
13205 PRINT
13210 IF Q=0 THEN 13205
13215 PRINT "THIS INCLUDES THE COMPONENT REPLACEMENT YOU REQUESTED"
13220 NEXT K
13225 PRINT "IF YOU WISH TO DO MORE COST ESTIMATES TYPE 1, IF NOT TYPE 0"
13230 INPUT Q7
13235 IF Q7=0 THEN 13300
13240 RESTORE #1
13245 RESTORE #2
13250 RESTORE #3
13255 MAT W=ZER(6,1)
13260 MAT L=ZER(7,1)
13265 MAT READ #1,W
13270 MAT READ #3,L
13275 FOR L=1 TO 5
13280 READ #2,M(L)
13285 NEXT L
13290 MAT D=ZER(10,10)
13295 GO TO 10295
13300 END
```

APPENDIX B

~~marrow, with disturbances of both erythropoiesis and myelopoiesis.~~

~~BIBLIOGRAPHY~~

~~Dinman, B. D. 1960. Arsenic; chronic human intoxication. J. Occup. Med. 2:137.~~

~~Elkins, H. B. 1959. The Chemistry of Industrial Toxicology, 2nd ed. John Wiley and Sons, New York.~~

~~Holmquist, L. 1951. Occupational arsenical dermatitis; a study among employees at a copper-ore smelting works including investigations of skin reactions to contact with arsenic compounds. Acta. Derm. Venereol. (Supp. 26) 31:1.~~

~~Pinto, S. S., and C. M. McGill. 1953. Arsenic trioxide exposure in industry. Ind. Med. Surg. 22:281.~~

~~Pinto, S. S., and K. W. Nelson. 1976. Arsenic toxicology and industrial exposure. Annu. Rev. Pharmacol. Toxicol. 16:95.~~

~~Vallee, B. L., D. D. Ulmer, and W. E. C. Wacker. 1960. Arsenic toxicology and biochemistry. AMA Arch. Indust. Health 21:132.~~

~~III. SPUTUM CYTOLOGY~~

~~Sputum can be collected by aerosol inhalation during the medical exam or by spontaneous early morning cough at home. Sputum is induced by transoral inhalation of an aerosolized solution of eight per cent (8 percent) sodium chloride in water. After inhaling as few as three to five breaths the subject usually yields an adequate sputum. All sputum should be collected directly into sixty percent (60 percent) alcohol.~~

~~Scientific evidence suggests that chest X-rays and sputum cytology should be used together as screening tests for lung tests for lung cancer in high risk populations such as workers exposed to inorganic arsenic. The tests are to be performed every six months on workers who are 45 years of age or older or have worked in the regulated area for 10 or more years. Since the tests seem to be complementary, it may be advantageous to alternate the test procedures. For instance, chest X-rays could be obtained in June and December and sputum cytologies could be obtained in March and September. Facilities for providing necessary diagnostic investigation should be readily available as well as chest physicians, surgeons, radiologists, pathologists and immunotherapists to provide any necessary treatment services.~~

~~[43 FR 19624, May 5, 1978; 43 FR 28472, June 30, 1978, as amended at 45 FR 35282, May 23, 1980; 54 FR 24334, June 7, 1989]~~

§ 1910.1025 Lead.

(a) *Scope and application.* (1) This section applies to all occupational exposure to lead, except as provided in

(2) This section does not apply to the construction industry or to agricultural operations covered by 29 CFR Part 1928.

(b) *Definitions. Action level* means employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air (30 $\mu g/m^3$) averaged over an 8-hour period.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Director means the Director, National Institute for Occupational Safety and Health (NIOSH), U.S. Department of Health, Education, and Welfare, or designee.

Lead means metallic lead, all inorganic lead compounds, and organic lead soaps. Excluded from this definition are all other organic lead compounds.

(c) *Permissible exposure limit (PEL).* (1) The employer shall assure that no employee is exposed to lead at concentrations greater than fifty micrograms per cubic meter of air (50 $\mu g/m^3$) averaged over an 8-hour period.

(2) If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a time weighted average (TWA) for that day, shall be reduced according to the following formula:

Maximum permissible limit (in $\mu g/m^3$) = 400 ÷ hours worked in the day.

(3) When respirators are used to supplement engineering and work practice controls to comply with the PEL and all the requirements of paragraph (f) have been met, employee exposure, for the purpose of determining whether the employer has complied with the PEL, may be considered to be at the level provided by the protection factor of the respirator for those periods the respirator is worn. Those periods may be averaged with exposure levels during periods when respirators are not worn to determine the employee's daily TWA exposure.

(d) *Exposure monitoring—*(1) *General.* (i) For the purposes of paragraph (d), employee exposure is that exposure which would occur if the employ

(ii) With the exception of monitoring under paragraph (d)(3), the employer shall collect full shift (for at least 7 continuous hours) personal samples including at least one sample for each shift for each job classification in each work area.

(iii) Full shift personal samples shall be representative of the monitored employee's regular, daily exposure to lead.

(2) *Initial determination.* Each employer who has a workplace or work operation covered by this standard shall determine if any exployee may be exposed to lead at or above the action level.

(3) *Basis of initial determination.* (i) The employer shall monitor employee exposures and shall base initial determinations on the employee exposure monitoring results and any of the following, relevant considerations:

(A) Any information, observations, or calculations which would indicate employee exposure to lead;

(B) Any previous measurements of airborne lead; and

(C) Any employee complaints of symptoms which may be attributable to exposure to lead.

(ii) Monitoring for the initial determination may be limited to a representative sample of the exposed employees who the employer reasonably believes are exposed to the greatest airborne concentrations of lead in the workplace.

(iii) Measurements of airborne lead made in the preceding 12 months may be used to satisfy the requirement to monitor under paragraph (d)(3)(i) if the sampling and analytical methods used meet the accuracy and confidence levels of paragraph (d)(9) of this section.

(4) *Positive initial determination and initial monitoring.* (i) Where a determination conducted under paragraphs (d) (2) and (3) of this section shows the possibility of any employee exposure at or above the action level, the employer shall conduct monitoring which is representative of the exposure for each employee in the workplace who is exposed to lead.

(ii) Measurements of airborne lead made in the preceding 12 months may

the sampling and analytical methods used meet the accuracy and confidence levels of paragraph (d)(9) of this section.

(5) *Negative initial determination.* Where a determination, conducted under paragraphs (d) (2) and (3) of this section is made that no employee is exposed to airborne concentrations of lead at or above the action level, the employer shall make a written record of such determination. The record shall include at least the information specified in paragraph (d)(3) of this section and shall also include the date of determination, location within the worksite, and the name and social security number of each employee monitored.

(6) *Frequency.* (i) If the initial monitoring reveals employee exposure to be below the action level the measurements need not be repeated except as otherwise provided in paragraph (d)(7) of this section.

(ii) If the initial determination or subsequent monitoring reveals employee exposure to be at or above the action level but below the permissible exposure limit the employer shall repeat monitoring in accordance with this paragraph at least every 6 months. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the action level at which time the employer may discontinue monitoring for that employee except as otherwise provided in paragraph (d)(7) of this section.

(iii) If the initial monitoring reveals that employee exposure is above the permissible exposure limit the employer shall repeat monitoring quarterly. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the PEL but at or above the action level at which time the employer shall repeat monitoring for that employee at the frequency specified in paragraph (d)(6)(ii), except as otherwise provided in paragraph (d)(7) of this section.

(7) *Additional monitoring.* Whenever there has been a production,

which may result in new or additional exposure to lead, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to lead, additional monitoring in accordance with this paragraph shall be conducted.

(8) *Employee notification.* (i) Within 5 working days after the receipt of monitoring results, the employer shall notify each employee in writing of the results which represent that employee's exposure.

(ii) Whenever the results indicate that the representative employee exposure, without regard to respirators, exceeds the permissible exposure limit, the employer shall incude in the written notice a statement that the permissible exposure limit was exceeded and a description of the corrective action taken or to be taken to reduce exposure to or below the permissible exposure limit.

(9) *Accuracy of measurement.* The employer shall use a method of monitoring and analysis which has an accuracy (to a confidence level of 95%) of not less than plus or minus 20 percent for airborne concentrations of lead equal to or greater than 30 µg/m³.

(e) *Methods of compliance*—(1) *Engineering and work practice controls.* (i) Where any employee is exposed to lead above the permissible exposure limit for more than 30 days per year, the employer shall implement engineering and work practice controls (including administrative controls) to reduce and maintain employee exposure to lead in accordance with the implementation schedule in Table I below, except to the extent that the employer can demonstrate that such controls are not feasible. Wherever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposure to or below the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest feasible level and shall supplement them by the use of respiratory protection which complies with the requirements of paragraph (f) of this section.

(ii) Where any employee is exposed to lead above the permissible exposure

the employer shall implement engineering controls to reduce exposures to 200 µg/m³, but thereafter may implement any combination of engineering, work practice (including administrative controls), and respiratory controls to reduce and maintain employee exposure to lead to or below 50 µg/m³.

TABLE I—IMPLEMENTATION SCHEDULE

Industry [1]	Compliance dates		
	200 µg/m³	100 µg/m³	50 µg/m³
Primary lead production	(³)	June 29, 1984 [2]	June 29, 1991.[3]
Secondary lead production	(³)	June 29, 1984 [3]	June 29, 1988.[2]
Lead acid battery manufacture	(³)	June 29, 1983 [3]	June 29, 1986.[2]
Automobile manufacture/ solder grinding	(³)	N/A	June 29, 1986.[3]
Electronics, gray iron foundries, ink manufacture, paints and coatings manufacture, wall paper manufacture, can manufacture and printing	(³)	N/A	June 29, 1982.[3]
Brass and bronze ingot manufacture, lead chemical manufacture, and secondary copper smelting	(³)	N/A	5 years.[4]
Non-ferrous foundries	(³)	N/A	5 years.[4], [5]
All other industries	(³)	N/A	2½ years.[4]

[1] Includes ancillary activities located on the same worksite.

[2] This date is calculated by counting, from June 29, 1981 (the date when the United States Supreme Court denied certiorari and lifted the stay on the implementation of paragraph (e)(1)), the number of years specified for the particular industry in the original lead standard for compliance with the given airborne exposure level. The denial of certiorari followed a decision of the United States Court of Appeals for the District of Columbia Circuit finding compliance with paragraph (e)(1) to be feasible for the relevant industries.

[3] On the effective date of this standard, March 1, 1979. This continues an obligation from Table Z-2 of 29 CFR 1910.1000, which has been in effect since 1971 but was deleted from the Code of Federal Regulations upon the effectiveness of this standard.

[4] Expressed as the number of years from the date on which the court lifts the stay on the implementation of paragraph (e)(1) for the particular industry.

[5] Large non-ferrous foundries (20 or more employees) are required to achieve 50 µg/m³ by means of engineering and work practice controls. Small non-ferrous foundries (fewer than 20 employees), however, are only required to achieve 75 µg/m³ by such controls. All foundries are required to comply within five years.

(2) *Respiratory protection.* Where engineering and work practice controls do not reduce employee exposure to or below the 50 µg/m³ permissible expo-

ment these controls with respirators in accordance with paragraph (f).

(3) *Compliance program.* (i) Each employer shall establish and implement a written compliance program to reduce exposures to or below the permissible exposure limit, and interim levels if applicable, solely by means of engineering and work practice controls in accordance with the implementation schedule in paragraph (e)(1).

(ii) Written plans for these compliance programs shall include at least the following:

(A) A description of each operation in which lead is emitted; e.g. machinery used, material processed, controls in place, crew size, employee job responsibilities, operating procedures and maintenance practices;

(B) A description of the specific means that will be employed to achieve compliance, including engineering plans and studies used to determine methods selected for controlling exposure to lead;

(C) A report of the technology considered in meeting the permissible exposure limit;

(D) Air monitoring data which documents the source of lead emissions;

(E) A detailed schedule for implementation of the program, including documentation such as copies of purchase orders for equipment, construction contracts, etc.;

(F) A work practice program which includes items required under paragraphs (g), (h) and (i) of this regulation;

(G) An administrative control schedule required by paragraph (e)(6), if applicable;

(H) Other relevant information.

(iii) Written programs shall be submitted upon request to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, Director, any affected employee or authorized employee representatives.

(iv) Written programs shall be revised and updated at least every 6 months to reflect the current status of the program.

(4) *Bypass of interim level.* Where an employer's compliance plan provides for a reduction of employee exposures to or below the PEL solely by means of engineering and work practice controls in accordance with the implementation schedule in table I, and the employer has determined that compliance with the 100 µg/m³ interim level would divert resources to the extent that it clearly precludes compliance, otherwise attainable, with the PEL by the required time, the employer may proceed with the plan to comply with the PEL in lieu of compliance with the interim level if:

(i) The compliance plan clearly documents the basis of the determination;

(ii) The employer takes all feasible steps to provide maximum protection for employees until the PEL is met; and

(iii) The employer notifies the OSHA Area Director nearest the affected workplace in writing within 10 working days of the completion or revision of the compliance plan reflecting the determination.

(5) *Mechanical ventilation.* (i) When ventilation is used to control exposure, measurements which demonstrate the effectiveness of the system in controlling exposure, such as capture velocity, duct velocity, or static pressure shall be made at least every 3 months. Measurements of the system's effectiveness in controlling exposure shall be made within 5 days of any change in production, process, or control which might result in a change in employee exposure to lead.

(ii) *Recirculation of air.* If air from exhaust ventilation is recirculated into the workplace, the employer shall assure that (A) the system has a high efficiency filter with reliable back-up filter; and (B) controls to monitor the concentration of lead in the return air and to bypass the recirculation system automatically if it fails are installed, operating, and maintained.

(6) *Administrative controls.* If administrative controls are used as a means of reducing employees TWA exposure to lead, the employer shall establish and implement a job rotation schedule which includes:

(i) Name or identification number of each affected employee;

(ii) Duration and exposure levels at each job or work station where each affected employee is located; and

(iii) Any other information which may be useful in assessing the reliability of administrative controls to reduce exposure to lead.

(f) *Respiratory protection*—(1) *General.* Where the use of respirators is required under this section, the employer shall provide, at no cost to the employee, and assure the use of respirators which comply with the requirements of this paragraph. Respirators shall be used in the following circumstances:

(i) During the time period necessary to install or implement engineering or work practice controls, except that after the dates for compliance with the interim levels in table I, no employer shall require an employee to wear a negative pressure respirator longer than 4.4 hours per day;

(ii) In work situations in which engineering and work practice controls are not sufficient to reduce exposures to or below the permissible exposure limit; and

(iii) Whenever an employee requests a respirator.

(2) *Respirator selection.* (i) Where respirators are required under this section the employer shall select the appropriate respirator or combination of respirators from table II below.

TABLE II—RESPIRATORY PROTECTION FOR LEAD AEROSOLS

Airborne concentration of lead or condition of use	Required respirator [1]
Not in excess of 0.5 mg/m³(10X PEL).	Half-mask, air-purifying respirator equipped with high efficiency filters.[2] [3]
Not in excess of 2.5 mg/m³(50X PEL).	Full facepiece, air-purifying respirator with high efficiency filters.[3]
Not in excess of 50 mg/m³(1000X PEL).	(1) Any powered, air-purifying respirator with high efficiency filters;[3] or (2) Half-mask supplied-air respirator operated in positive-pressure mode.[3]
Not in excess of 100 mg/m³(2000XPEL).	Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive pressure mode.
Greater than 100 mg/m³, unknown concentration or fire fighting.	Full facepiece, self-contained breathing apparatus operated in positive-pressure mode.

(ii) The employer shall provide a powered, air-purifying respirator in lieu of the respirator specified in Table II whenever:

(A) An employee chooses to use this type of respirator; and

(B) This respirator will provide adequate protection to the employee.

(iii) The employer shall select respirators from among those approved for protection against lead dust, fume, and mist by the Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

(3) *Respirator usage.* (i) The employer shall assure that the respirator issued to the employee exhibits minimum facepiece leakage and that the respirator is fitted properly.

(ii) Employers shall perform either quantitative or qualitative face fit tests at the time of initial fitting and at least every six months thereafter for each employee wearing negative pressure respirators. The qualitative fit tests may be used only for testing the fit of half-mask respirators where they are permitted to be worn, and shall be conducted in accordance with Appendix D. The tests shall be used to select facepieces that provide the required protection as prescribed in table II.

(iii) If an employee exhibits difficulty in breathing during the fitting test or during use, the employer shall make available to the employee an examination in accordance with paragraph (j)(3)(i)(C) of this section to determine whether the employee can wear a respirator while performing the required duty.

(4) *Respirator program.* (i) The employer shall institute a respiratory protection program in accordance with 29 CFR 1910.134 (b), (d), (e) and (f).

(ii) The employer shall permit each employee who uses a filter respirator to change the filter elements whenever an increase in breathing resistance is detected and shall maintain an adequate supply of filter elements for this purpose.

(iii) Employees who wear respirators shall be permitted to leave work areas to wash their face and respirator face-

skin irritation associated with respirator use.

(g) *Protective work clothing and equipment*—(1) *Provision and use.* If an employee is exposed to lead above the PEL, without regard to the use of respirators or where the possibility of skin or eye irritation exists, the employer shall provide at no cost to the employee and assure that the employee uses appropriate protective work clothing and equipment such as, but not limited to:

(i) Coveralls or similar full-body work clothing;

(ii) Gloves, hats, and shoes or disposable shoe coverlets; and

(iii) Face shields, vented goggles, or other appropriate protective equipment which complies with § 1910.133 of this Part.

(2) *Cleaning and replacement.* (i) The employer shall provide the protective clothing required in paragraph (g)(1) of this section in a clean and dry condition at least weekly, and daily to employees whose exposure levels without regard to a respirator are over 200 μg/m³ of lead as an 8-hour TWA.

(ii) The employer shall provide for the cleaning, laundering, or disposal of protective clothing and equipment required by paragraph (g)(1) of this section.

(iii) The employer shall repair or replace required protective clothing and equipment as needed to maintain their effectiveness.

(iv) The employer shall assure that all protective clothing is removed at the completion of a work shift only in change rooms provided for that purpose as prescribed in paragraph (i)(2) of this section.

(v) The employer shall assure that contaminated protective clothing which is to be cleaned, laundered, or disposed of, is placed in a closed container in the change-room which prevents dispersion of lead outside the container.

(vi) The employer shall inform in writing any person who cleans or launders protective clothing or equipment of the potentially harmful effects of exposure to lead.

(vii) The employer shall assure that the containers of contaminated protective clothing and equipment required by paragraph (g)(2)(v) are labelled as follows: CAUTION: CLOTHING CONTAMINATED WITH LEAD. DO NOT REMOVE DUST BY BLOWING OR SHAKING. DISPOSE OF LEAD CONTAMINATED WASH WATER IN ACCORDANCE WITH APPLICABLE LOCAL, STATE, OR FEDERAL REGULATIONS.

(viii) The employer shall prohibit the removal of lead from protective clothing or equipment by blowing, shaking, or any other means which disperses lead into the air.

(h) *Housekeeping*—(1) *Surfaces.* All surfaces shall be maintained as free as practicable of accumulations of lead.

(2) *Cleaning floors.* (i) Floors and other surfaces where lead accumulates may not be cleaned by the use of compressed air.

(ii) Shoveling, dry or wet sweeping, and brushing may be used only where vacuuming or other equally effective methods have been tried and found not to be effective.

(3) *Vacuuming.* Where vacuuming methods are selected, the vacuums shall be used and emptied in a manner which minimizes the reentry of lead into the workplace.

(i) *Hygiene facilities and practices.* (1) The employer shall assure that in areas where employees are exposed to lead above the PEL, without regard to the use of respirators, food or beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in change rooms, lunchrooms, and showers required under paragraphs (i)(2) through (i)(4) of this section.

(2) *Change rooms.* (i) The employer shall provide clean change rooms for employees who work in areas where their airborne exposure to lead is above the PEL, without regard to the use of respirators.

(ii) The employer shall assure that change rooms are equipped with separate storage facilities for protective work clothing and equipment and for street clothes which prevent cross-contamination.

(3) *Showers.* (i) The employer shall assure that employees who work in areas where their airborne exposure to lead is above the PEL, without regard

---

[1] Respirators specified for high concentrations can be used at lower concentrations of lead.

[2] Full facepiece is required if the lead aerosols cause eye

to the use of respirators, shower at the end of the work shift.

(ii) The employer shall provide shower facilities in accordance with § 1910.141 (d)(3) of this part.

(iii) The employer shall assure that employees who are required to shower pursuant to paragraph (i)(3)(i) do not leave the workplace wearing any clothing or equipment worn during the work shift.

(4) *Lunchrooms.* (i) The employer shall provide lunchroom facilities for employees who work in areas where their airborne exposure to lead is above the PEL, without regard to the use of respirators.

(ii) The employer shall assure that lunchroom facilities have a temperature controlled, positive pressure, filtered air supply, and are readily accessible to employees.

(iii) The employer shall assure that employees who work in areas where their airborne exposure to lead is above the PEL without regard to the use of a respirator wash their hands and face prior to eating, drinking, smoking or applying cosmetics.

(iv) The employer shall assure that employees do not enter lunchroom facilities with protective work clothing or equipment unless surface lead dust has been removed by vacuuming, downdraft booth, or other cleaning method.

(5) *Lavatories.* The employer shall provide an adequate number of lavatory facilities which comply with § 1910.141(d) (1) and (2) of this part.

(j) *Medical surveillance*—(1) *General.* (i) The employer shall institute a medical surveillance program for all employees who are or may be exposed above the action level for more than 30 days per year.

(ii) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician.

(iii) The employer shall provide the required medical surveillance including multiple physician review under paragraph (j)(3)(iii) without cost to employees and at a reasonable time and place.

(2) *Biological monitoring*—(i) *Blood*

able biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin levels to each employee covered under paragraph (j)(1)(i) of this section on the following schedule:

(A) At least every 6 months to each employee covered under paragraph (j)(1)(i) of this section;

(B) At least every two months for each employee whose last blood sampling and analysis indicated a blood lead level at or above 40 $\mu g/100$ g of whole blood. This frequency shall continue until two consecutive blood samples and analyses indicate a blood lead level below 40 $\mu g/100$ g of whole blood; and

(C) At least monthly during the removal period of each employee removed from exposure to lead due to an elevated blood lead level.

(ii) *Follow-up blood sampling tests.* Whenever the results of a blood lead level test indicate that an employee's blood lead level exceeds the numerical criterion for medical removal under paragraph (k)(1)(i), the employer shall provide a second (follow-up) blood sampling test within two weeks after the employer receives the results of the first blood sampling test.

(iii) *Accuracy of blood lead level sampling and analysis.* Blood lead level sampling and analysis provided pursuant to this section shall have an accuracy (to a confidence level of 95 percent) within plus or minus 15 percent or 6 $\mu g/100ml$, whichever is greater, and shall be conducted by a laboratory licensed by the Center for Disease Control, United States Department of Health, Education and Welfare (CDC) or which has received a satisfactory grade in blood lead proficiency testing from CDC in the prior twelve months.

(iv) *Employee notification.* Within five working days after the receipt of biological monitoring results, the employer shall notify in writing each employee whose blood lead level exceeds 40 $\mu g/100$ g: (A) of that employee's blood lead level and (B) that the standard requires temporary medical removal with Medical Removal Protection benefits when an employee's blood lead level exceeds the numerical criterion for medical removal under

(3) *Medical examinations and consultations*—(i) *Frequency.* The employer shall make available medical examinations and consultations to each employee covered under paragraph (j)(1)(i) of this section on the following schedule:

(A) At least annually for each employee for whom a blood sampling test conducted at any time during the preceding 12 months indicated a blood lead level at or above 40 $\mu g/100$ g;

(B) Prior to assignment for each employee being assigned for the first time to an area in which airborne concentrations of lead are at or above the action level;

(C) As soon as possible, upon notification by an employee either that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice concerning the effects of current or past exposure to lead on the employee's ability to procreate a healthy child, or that the employee has demonstrated difficulty in breathing during a respirator fitting test or during use; and

(D) As medically appropriate for each employee either removed from exposure to lead due to a risk of sustaining material impairment to health, or otherwise limited pursuant to a final medical determination.

(ii) *Content.* Medical examinations made available pursuant to paragraph (j)(3)(i) (A) through (B) of this section shall include the following elements:

(A) A detailed work history and a medical history, with particular attention to past lead exposure (occupational and non-occupational), personal habits (smoking, hygiene), and past gastrointestinal, hematologic, renal, cardiovascular, reproductive and neurological problems;

(B) A thorough physical examination, with particular attention to teeth, gums, hematologic, gastrointestinal, renal, cardiovascular, and neurological systems. Pulmonary status should be evaluated if respiratory protection will be used;

(C) A blood pressure measurement;

(D) A blood sample and analysis which determines:

(*1*) Blood lead level;

(*2*) Hemoglobin and hematocrit determinations, red cell indices, and examination of peripheral smear morphology;

(*3*) Zinc protoporphyrin;

(*4*) Blood urea nitrogen; and,

(*5*) Serum creatinine;

(E) A routine urinalysis with microscopic examination; and

(F) Any laboratory or other test which the examining physician deems necessary by sound medical practice.

The content of medical examinations made available pursuant to paragraph (j)(3)(i) (C) through (D) of this section shall be determined by an examining physician and, if requested by an employee, shall include pregnancy testing or laboratory evaluation of male fertility.

(iii) *Multiple physician review mechanism.* (A) If the employer selects the initial physician who conducts any medical examination or consultation provided to an employee under this section, the employee may designate a second physician:

(*1*) To review any findings, determinations or recommendations of the initial physician; and

(*2*) To conduct such examinations, consultations, and laboratory tests as the second physician deems necessary to facilitate this review.

(B) The employer shall promptly notify an employee of the right to seek a second medical opinion after each occasion that an initial physician conducts a medical examination or consultation pursuant to this section. The employer may condition its participation in, and payment for, the multiple physician review mechanism upon the employee doing the following within fifteen (15) days after receipt of the foregoing notification, or receipt of the initial physician's written opinion, whichever is later:

(*1*) The employee informing the employer that he or she intends to seek a second medical opinion, and

(*2*) The employee initiating steps to make an appointment with a second physician.

(C) If the findings, determinations or recommendations of the second physician differ from those of the initial physician, then the employer and

he employee shall assure that efforts re made for the two physicians to resolve any disagreement.

(D) If the two physicians have been unable to quickly resolve their disagreement, then the employer and the employee through their respective physicians shall designate a third physician:

(*1*) To review any findings, determinations or recommendations of the prior physicians; and

(*2*) To conduct such examinations, consultations, laboratory tests and discussions with the prior physicians as the third physician deems necessary to resolve the disagreement of the prior physicians.

(E) The employer shall act consistent with the findings, determinations and recommendations of the third physician, unless the employer and the employee reach an agreement which is otherwise consistent with the recommendations of at least one of the three physicians.

(iv) *Information provided to examining and consulting physicians.* (A) The employer shall provide an initial physician conducting a medical examination or consultation under this section with the following information:

(*1*) A copy of this regulation for lead including all Appendices;

(*2*) A description of the affected employee's duties as they relate to the employee's exposure;

(*3*) The employee's exposure level or anticipated exposure level to lead and to any other toxic substance (if applicable);

(*4*) A description of any personal protective equipment used or to be used;

(*5*) Prior blood lead determinations; and

(*6*) All prior written medical opinions concerning the employee in the employer's possession or control.

(B) The employer shall provide the foregoing information to a second or third physician conducting a medical examination or consultation under this section upon request either by the second or third physician, or by the employee.

(v) *Written medical opinions.* (A) The employer shall obtain and furnish

medical opinion from each examining or consulting physician which contains the following information:

(*1*) The physician's opinion as to whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to lead;

(*2*) Any recommended special protective measures to be provided to the employee, or limitations to be placed upon the employee's exposure to lead;

(*3*) Any recommended limitation upon the employee's use of respirators, including a determination of whether the employee can wear a powered air purifying respirator if a physician determines that the employee cannot wear a negative pressure respirator; and

(*4*) The results of the blood lead determinations.

(B) The employer shall instruct each examining and consulting physician to:

(*1*) Not reveal either in the written opinion, or in any other means of communication with the employer, findings, including laboratory results, or diagnoses unrelated to an employee's occupational exposure to lead; and

(*2*) Advise the employee of any medical condition, occupational or nonoccupational, which dictates further medical examination or treatment.

(vi) *Alternate Physician Determination Mechanisms.* The employer and an employee or authorized employee representative may agree upon the use of any expeditious alternate physician determination mechanism in lieu of the multiple physician review mechanism provided by this paragraph so long as the alternate mechanism otherwise satisfies the requirements contained in this paragraph.

(4) *Chelation.* (i) The employer shall assure that any person whom he retains, employs, supervises or controls does not engage in prophylactic chelation of any employee at any time.

(ii) If therapeutic or diagnostic chelation is to be performed by any person in paragraph (j)(4)(i), the employer shall assure that it be done under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical

monitoring and that the employee is notified in writing prior to its occurrence.

(k) *Medical Removal Protection*—(1) *Temporary medical removal and return of an employee*—(i) *Temporary removal due to elevated blood lead levels*—(A) *First year of the standard.* During the first year following the effective date of the standard, the employer shall remove an employee from work having a daily eight hour TWA exposure to lead at or above 100 μg/m³ on each occasion that a periodic and a follow-up blood sampling test conducted pursuant to this section indicate that the employee's blood lead level is at or above 80 μg/100 g of whole blood;

(B) *Second year of the standard.* During the second year following the effective date of the standard, the employer shall remove an employee from work having a daily 8-hour TWA exposure to lead at or above 50 μg/m³ on each occasion that a periodic and a follow-up blood sampling test conducted pursuant to this section indicate that the employee's blood lead level is at or above 70 μg/100 g of whole blood;

(C) *Third year of the standard, and thereafter.* Beginning with the third year following the effective date of the standard, the employer shall remove an employee from work having an exposure to lead at or above the action level on each occasion that a periodic and a follow-up blood sampling test conducted pursuant to this section indicate that the employee's blood lead level is at or above 60 μg/100 g of whole blood; and,

(D) *Fifth year of the standard, and thereafter.* Beginning with the fifth year following the effective date of the standard, the employer shall remove an employee from work having an exposure to lead at or above the action level on each occasion that the average of the last three blood sampling tests conducted pursuant to this section (or the average of all blood sampling tests conducted over the previous six (6) months, whichever is longer) indicates that the employee's blood lead level is at or above 50 μg/100 g of whole blood; provided, however, that an employee need not be removed if the last blood sampling test indicates a blood lead level at or below 40 μg/100 g of whole blood.

(ii) *Temporary removal due to a final medical determination.* (A) The employer shall remove an employee from work having an exposure to lead at or above the action level on each occasion that a final medical determination results in a medical finding, determination, or opinion that the employee has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to lead.

(B) For the purposes of this section, the phrase "final medical determination" shall mean the outcome of the multiple physician review mechanism or alternate medical determination mechanism used pursuant to the medical surveillance provisions of this section.

(C) Where a final medical determination results in any recommended special protective measures for an employee, or limitations on an employee's exposure to lead, the employer shall implement and act consistent with the recommendation.

(iii) *Return of the employee to former job status.* (A) The employer shall return an employee to his or her former job status:

(*1*) For an employee removed due to a blood lead level at or above 80 μg/100 g, when two consecutive blood sampling tests indicate that the employee's blood lead level is at or below 60 μg/100 g of whole blood;

(*2*) For an employee removed due to a blood lead level at or above 70 μg/100 g, when two consecutive blood sampling tests indicate that the employee's blood lead level is at or below 50 μg/100 g of whole blood;

(*3*) For an employee removed due to a blood lead level at or above 60 μg/100 g, or due to an average blood lead level at or above 50 μg/100 g, when two consecutive blood sampling tests indicate that the employee's blood lead level is at or below 40 μg/100 g of whole blood;

(*4*) For an employee removed due to a final medical determination, when a subsequent final medical determination results in a medical finding, determination, or opinion that the employee no longer has a detected medical

condition which places the employee at increased risk of material impairment to health from exposure to lead.

(B) For the purposes of this section, the requirement that an employer return an employee to his or her former job status is not intended to expand upon or restrict any rights an employee has or would have had, absent temporary medical removal, to a specific job classification or position under the terms of a collective bargaining agreement.

(iv) *Removal of other employee special protective measure or limitations.* The employer shall remove any limitations placed on an employee or end any special protective measures provided to an employee pursuant to a final medical determination when a subsequent final medical determination indicates that the limitations or special protective measures are no longer necessary.

(v) *Employer options pending a final medical determination.* Where the multiple physician review mechanism, or alternate medical determination mechanism used pursuant to the medical surveillance provisions of this section, has not yet resulted in a final medical determination with respect to an employee, the employer shall act as follows:

(A) *Removal.* The employer may remove the employee from exposure to lead, provide special protective measures to the employee, or place limitations upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status.

(B) *Return.* The employer may return the employee to his or her former job status, end any special protective measures provided to the employee, and remove any limitations placed upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status, with two exceptions. If (*1*) the initial removal, special protection, or limitation of the employee resulted from a final medical determination which differed from the findings, determinations, or recommendations of the initial physician or

(*2*) The employee has been on removal status for the preceding eighteen months due to an elevated blood lead level, then the employer shall await a final medical determination.

(2) *Medical removal protection benefits*—(i) *Provision of medical removal protection benefits.* The employer shall provide to an employee up to eighteen (18) months of medical removal protection benefits on each occasion that an employee is removed from exposure to lead or otherwise limited pursuant to this section.

(ii) *Definition of medical removal protection benefits.* For the purposes of this section, the requirement that an employer provide medical removal protection benefits means that the employer shall maintain the earnings, seniority and other employment rights and benefits of an employee as though the employee had not been removed from normal exposure to lead or otherwise limited.

(iii) *Follow-up medical surveillance during the period of employee removal or limitation.* During the period of time that an employee is removed from normal exposure to lead or otherwise limited, the employer may condition the provision of medical removal protection benefits upon the employee's participation in follow-up medical surveillance made available pursuant to this section.

(iv) *Workers' compensation claims.* If a removed employee files a claim for workers' compensation payments for a lead-related disability, then the employer shall continue to provide medical removal protection benefits pending disposition of the claim. To the extent that an award is made to the employee for earnings lost during the period of removal, the employer's medical removal protection obligation shall be reduced by such amount. The employer shall receive no credit for workers' compensation payments received by the employee for treatment related expenses.

(v) *Other credits.* The employer's obligation to provide medical removal protection benefits to a removed employee shall be reduced to the extent that the employee receives compensation for earnings lost during the period of removal either from a publicly or employer-funded compensation program, or receives income from employment with another employer made possible by virtue of the employee's removal.

(vi) *Employees whose blood lead levels do not adequately decline within 18 months of removal.* The employer shall take the following measures with respect to any employee removed from exposure to lead due to an elevated blood lead level whose blood lead level has not declined within the past eighteen (18) months of removal so that the employee has been returned to his or her former job status:

(A) The employer shall make available to the employee a medical examination pursuant to this section to obtain a final medical determination with respect to the employee;

(B) The employer shall assure that the final medical determination obtained indicates whether or not the employee may be returned to his or her former job status, and if not, what steps should be taken to protect the employee's health;

(C) Where the final medical determination has not yet been obtained, or once obtained indicates that the employee may not yet be returned to his or her former job status, the employer shall continue to provide medical removal protection benefits to the employee until either the employee is returned to former job status, or a final medical determination is made that the employee is incapable of ever safely returning to his or her former job status.

(D) Where the employer acts pursuant to a final medical determination which permits the return of the employee to his or her former job status despite what would otherwise be an unacceptable blood lead level, later questions concerning removing the employee again shall be decided by a final medical determination. The employer need not automatically remove such an employee pursuant to the blood lead level removal criteria provided by this section.

(vii) *Voluntary Removal or Restriction of An Employee.* Where an employer, although not required by this section to do so, removes an employee from exposure to lead or otherwise places limitations on an employee due to the effects of lead exposure on the employee's medical condition, the employer shall provide medical removal protection benefits to the employee equal to that required by paragraph (k)(2)(i) of this section.

(l) *Employee information and training*—(1) *Training program.* (i) Each employer who has a workplace in which there is a potential exposure to airborne lead at any level shall inform employees of the content of Appendices A and B of this regulation.

(ii) The employer shall institute a training program for and assure the participation of all employees who are subject to exposure to lead at or above the action level or for whom the possibility of skin or eye irritation exists.

(iii) The employer shall provide initial training by 180 days from the effective date for those employees covered by paragraph (l)(1) (ii) on the standard's effective date and prior to the time of initial job assignment for those employees subsequently covered by this paragraph.

(iv) The training program shall be repeated at least annually for each employee.

(v) The employer shall assure that each employee is informed of the following:

(A) The content of this standard and its appendices;

(B) The specific nature of the operations which could result in exposure to lead above the action level;

(C) The purpose, proper selection, fitting, use, and limitations of respirators;

(D) The purpose and a description of the medical surveillance program, and the medical removal protection program including information concerning the adverse health effects associated with excessive exposure to lead (with particular attention to the adverse reproductive effects on both males and females);

(E) The engineering controls and work practices associated with the employee's job assignment;

(F) The contents of any compliance plan in effect; and

(G) Instructions to employees that chelating agents should not routinely be used to remove lead from their bodies and should not be used at all except under the direction of a licensed physician;

(2) *Access to information and training materials.* (i) The employer shall make readily available to all affected employees a copy of this standard and its appendices.

(ii) The employer shall provide, upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.

(iii) In addition to the information required by paragraph (l)(1)(v), the employer shall include as part of the training program, and shall distribute to employees, any materials pertaining to the Occupational Safety and Health Act, the regulations issued pursuant to that Act, and this lead standard, which are made available to the employer by the Assistant Secretary.

(m) *Signs*—(1) *General.* (i) The employer may use signs required by other statutes, regulations or ordinances in addition to, or in combination with, signs required by this paragraph.

(ii) The employer shall assure that no statement appears on or near any sign required by this paragraph which contradicts or detracts from the meaning of the required sign.

(2) *Signs.* (i) The employer shall post the following warning signs in each work area where the PEL is exceeded:

WARNING

LEAD WORK AREA

POISON

NO SMOKING OR EATING

(ii) The employer shall assure that signs required by this paragraph are illuminated and cleaned as necessary so that the legend is readily visible.

(n) *Recordkeeping*—(1) *Exposure monitoring.* (i) The employer shall establish and maintain an accurate record of all monitoring required in paragraph (d) of this section.

(ii) This record shall include:

(A) The date(s), number, duration, location and results of each of the of the sampling procedure used to determine representative employee exposure where applicable;

(B) A description of the sampling and analytical methods used and evidence of their accuracy;

(C) The type of respiratory protective devices worn, if any;

(D) Name, social security number, and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent; and

(E) The environmental variables that could affect the measurement of employee exposure.

(iii) The employer shall maintain these monitoring records for at least 40 years or for the duration of employment plus 20 years, whichever is longer.

(2) *Medical surveillance.* (i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (j) of this section.

(ii) This record shall include:

(A) The name, social security number, and description of the duties of the employee;

(B) A copy of the physician's written opinions;

(C) Results of any airborne exposure monitoring done for that employee and the representative exposure levels supplied to the physician; and

(D) Any employee medical complaints related to exposure to lead.

(iii) The employer shall keep, or assure that the examining physician keeps, the following medical records:

(A) A copy of the medical examination results including medical and work history required under paragraph (j) of this section;

(B) A description of the laboratory procedures and a copy of any standards or guidelines used to interpret the test results or references to that information;

(C) A copy of the results of biological monitoring.

(iv) The employer shall maintain or assure that the physician maintains those medical records for at least 40 years, or for the duration of employment plus 20 years, whichever is longer.

(3) *Medical removals.* (i) The employer shall establish and maintain an accurate record for each employee removed from current exposure to lead pursuant to paragraph (k) of this section.

(ii) Each record shall include:

(A) The name and social security number of the employee;

(B) The date on each occasion that the employee was removed from current exposure to lead as well as the corresponding date on which the employee was returned to his or her former job status;

(C) A brief explanation of how each removal was or is being accomplished; and

(D) A statement with respect to each removal indicating whether or not the reason for the removal was an elevated blood lead level.

(iii) The employer shall maintain each medical removal record for at least the duration of an employee's employment.

(4) *Availability.* (i) The employer shall make available upon request all records required to be maintained by paragraph (n) of this section to the Assistant Secretary and the Director for examination and copying.

(ii) Environmental monitoring, medical removal, and medical records required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a)-(e) and (2)-(i). Medical removal records shall be provided in the same manner as environmental monitoring records.

(5) *Transfer of records.* (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (n) of this section.

(ii) Whenever the employer ceases to do business and there is no successor employer to receive and retain the records required to be maintained by this section for the prescribed period, these records shall be transmitted to the Director.

(iii) At the expiration of the retention period for the records required to be maintained by this section, the employer shall notify the Director at least 3 months prior to the disposal of such records and shall transmit those records to the Director if requested within the period.

(iv) The employer shall also comply with any additional requirements involving transfer of records set forth in 29 CFR 1910.20(h).

(o) *Observation of monitoring.* (1) *Employee observation.* The employer shall provide affected employees or their designated representatives an opportunity to observe any monitoring of employee exposure to lead conducted pursuant to paragraph (d) of this section.

(2) *Observation procedures.* (i) Whenever observation of the monitoring of employee exposure to lead requires entry into an area where the use of respirators, protective clothing or equipment is required, the employer shall provide the observer with and assure the use of such respirators, clothing and such equipment, and shall require the observer to comply with all other applicable safety and health procedures.

(ii) Without interfering with the monitoring, observers shall be entitled to:

(A) Receive an explanation of the measurement procedures;

(B) Observe all steps related to the monitoring of lead performed at the place of exposure; and

(C) Record the results obtained or receive copies of the results when returned by the laboratory.

(p) *Effective date.* This standard shall become effective March 1, 1979.

(q) *Appendices.* The information contained in the appendices to this section is not intended by itself, to create any additional obligations not otherwise imposed by this standard nor detract from any existing obligation.

(r) *Startup dates.* All obligations of this standard commence on the effective date except as follows:

(1) The initial determination under paragraph (d)(2) shall be made as soon as possible but no later than 30 days from the effective date.

(2) Initial monitoring under paragraph (d)(4) shall be completed as soon as possible but no later than 90 days from the effective date.

(3) Initial biological monitoring and medical examinations under paragraph (j) shall be completed as soon as possible but no later than 180 days from the effective date. Priority for biological monitoring and medical examinations shall be given to employees whom the employer believes to be at greatest risk from continued exposure.

(4) Initial training and education shall be completed as soon as possible but no later than 180 days from the effective date.

(5) Hygiene and lunchroom facilities under paragraph (i) shall be in operation as soon as possible but no later than 1 year from the effective year.

(6)(i) Respiratory protection required by paragraph (f) shall be provided as soon as possible but no later than the following schedule:

(A) Employees whose 8-hour TWA exposure exceeds 200 $\mu g/m^3$—on the effective date.

(B) Employees whose 8-hour TWA exposure exceeds the PEL but is less than 200 $\mu g/m^3$—150 days from the effective date.

(C) Powered, air-purifying respirators provided under (f)(2)(ii)—210 days from the effective date.

(D) Quantitative fit testing required under (f)(3)(ii)—one year from effective date. Qualitative fit testing is required in the interim.

(7)(i) Written compliance plans required by paragraph (e)(3) shall be completed and available for inspection and copying as soon as possible but no later than the following schedule:

(A) Employers for whom compliance with the PEL or interim level is required within 1 year from the effective date—6 months from the effective date.

(B) Employers in secondary lead smelting and refining and in lead storage battery manufacturing—1 year from the effective date.

(C) Employers in primary smelting and refining industry—1 year from the effective date for the interim level; 5 years from the effective date for PEL.

(D) Plans for construction of hygiene facilities, if required—6 months from the effective date.

(E) All other industries—1 year from the date on which the court lifts the stay on the implementation of paragraph (e)(1) for the particular industry.

(8) The permissible exposure limit in paragraph (c) shall become effective 150 days from the effective date.

(Approved by the Office of Management and Budget under control number 1218-0092)

APPENDIX A TO § 1910.1025—SUBSTANCE DATA SHEET FOR OCCUPATIONAL EXPOSURE TO LEAD

I. SUBSTANCE IDENTIFICATION

A. *Substance:* Pure lead (Pb) is a heavy metal at room temperature and pressure and is a basic chemical element. It can combine with various other substances to form numerous lead compounds.

B. *Compounds Covered by the Standard:* The word "lead" when used in this standard means elemental lead, all inorganic lead compounds and a class of organic lead compounds called lead soaps. This standard does not apply to other organic lead compounds.

C. *Uses:* Exposure to lead occurs in at least 120 different occupations, including primary and secondary lead smelting, lead storage battery manufacturing, lead pigment manufacturing and use, solder manufacturing and use, shipbuilding and ship repairing, auto manufacturing, and printing.

D. *Permissible Exposure:* The Permissible Exposure Limit (PEL) set by the standard is 50 micrograms of lead per cubic meter of air (50 $\mu g/m^3$), averaged over an 8-hour workday.

E. *Action Level:* The standard establishes an action level of 30 micrograms per cubic meter of air (30 $\mu g/m^3$), time weighted average, based on an 8-hour work-day. The action level initiates several requirements of the standard, such as exposure monitoring, medical surveillance, and training and education.

II. HEALTH HAZARD DATA

A. *Ways in which lead enters your body.* When absorbed into your body in certain doses lead is a toxic substance. The object of the lead standard is to prevent absorption of harmful quantities of lead. The standard is intended to protect you not only from the immediate toxic effects of lead, but also from the serious toxic effects that may not become apparent until years of exposure have passed.

Lead can be absorbed into your body by inhalation (breathing) and ingestion (eating). Lead (except for certain organic lead compounds not covered by the standard, such as tetraethyl lead) is not absorbed through your skin. When lead is scattered in the air as a dust, fume or mist it can be inhaled and absorbed through you lungs and upper respiratory tract. Inhalation of airborne lead is generally the most important source of occupational lead absorption. You can also absorb lead through your digestive system if lead gets into your mouth and is swallowed. If you handle food, cigarettes, chewing tobacco, or make-up which have lead on them or handle them with hands contaminated with lead, this will contribute to ingestion.

A significant portion of the lead that you inhale or ingest gets into your blood stream. Once in your blood stream, lead is circulated throughout your body and stored in various organs and body tissues. Some of this lead is quickly filtered out of your body and excreted, but some remains in the blood and other tissues. As exposure to lead continues, the amount stored in your body will increase if you are absorbing more lead than your body is excreting. Even though you may not be aware of any immediate symptoms of disease, this lead stored in your tissues can be slowly causing irreversible damage, first to individual cells, then to your organs and whole body systems.

B. *Effects of overexposure to lead*—(1) *Short term (acute) overexposure.* Lead is a potent, systemic poison that serves no known useful function once absorbed by your body. Taken in large enough doses, lead can kill you in a matter of days. A condition affecting the brain called acute encephalopathy may arise which develops quickly to seizures, coma, and death from cardiorespiratory arrest. A short term dose of lead can lead to acute encephalopathy. Short term occupational exposures of this magnitude are highly unusual, but not impossible. Similar forms of encephalopathy may, however, arise from extended, chronic exposure to lower doses of lead. There is no sharp dividing line between rapidly developing acute effects of lead, and chronic effects which take longer to acquire. Lead adversely affects numerous body systems, and causes forms of health impairment and disease which arise after periods of exposure as short as days or as long as several years.

(2) *Long-term (chronic) overexposure.* Chronic overexposure to lead may result in severe damage to your blood-forming, nervous, urinary and reproductive systems. Some common symptoms of chronic overexposure include loss of appetite, metallic taste in the mouth, anxiety, constipation, nausea, pallor, excessive tiredness, weakness, insomnia, headache, nervous irritability, muscle and joint pain or soreness, fine tremors, numbness, dizziness, hyperactivity and colic. In lead colic there may be severe abdominal pain.

Damage to the central nervous system in general and the brain (encephalopathy) in particular is one of the most severe forms of lead poisoning. The most severe, often fatal, form of encephalopathy may be preceded by vomiting, a feeling of dullness progressing to drowsiness and stupor, poor memory, restlessness, irritability, tremor, and convulsions. It may arise suddenly with the onset of seizures, followed by coma, and death. There is a tendency for muscular weakness to develop at the same time. This weakness may progress to paralysis often observed as a characteristic "wrist drop" or "foot drop" and is a manifestation of a disease to the nervous system called peripheral neuropathy.

Chronic overexposure to lead also results in kidney disease with few, if any, symptoms appearing until extensive and most likely permanent kidney damage has occurred. Routine laboratory tests reveal the presence of this kidney disease only after about two-thirds of kidney function is lost. When overt symptoms of urinary dysfunction arise, it is often too late to correct or prevent worsening conditions, and progression to kidney dialysis or death is possible.

Chronic overexposure to lead impairs the reproductive systems of both men and women. Overexposure to lead may result in decreased sex drive, impotence and sterility in men. Lead can alter the structure of sperm cells raising the risk of birth defects. There is evidence of miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves. Lead exposure also may result in decreased fertility, and abnormal menstrual cycles in women. The course of pregnancy may be adversely affected by exposure to lead since lead crosses the placental barrier and poses risks to developing fetuses. Children born of parents either one of whom were exposed to excess lead levels are more likely to have birth defects, mental retardation, behavioral disorders or die during the first year of childhood.

Overexposure to lead also disrupts the blood-forming system resulting in decreased hemoglobin (the substance in the blood that carries oxygen to the cells) and ultimately anemia. Anemia is characterized by weakness, pallor and fatigability as a result of decreased oxygen carrying capacity in the blood.

(3) *Health protection goals of the standard.* Prevention of adverse health effects for most workers from exposure to lead throughout a working lifetime requires that worker blood lead (PbB) levels be maintained at or below forty micrograms per one hundred grams of whole blood (40 $\mu g/100g$). The blood lead levels of workers (both male and female workers) who intend to have children should be maintained below 30 $\mu g/100g$ to minimize adverse reproductive health effects to the parents and to the developing fetus.

The measurement of your blood lead level is the most useful indicator of the amount of lead being absorbed by your body. Blood lead levels (PbB) are most often reported in

units of milligrams (mg) or micrograms (μg) of lead (1 mg=1000 μg) per 100 grams (100g), 100 milliters (100 ml) or deciliter (dl) of blood. These three units are essentially the same. Sometime PbB's are expressed in the form of mg% or μg%. This is a shorthand notation for 100g, 100 ml, or dl.

PbB measurements show the amount of lead circulating in your blood stream, but do not give any information about the amount of lead stored in your various tissues. PbB measurements merely show current absorption of lead, not the effect that lead is having on your body or the effects that past lead exposure may have already caused. Past research into lead-related diseases, however, has focused heavily on associations between PbBs and various diseases. As a result, your PbB is an important indicator of the likelihood that you will gradually acquire a lead-related health impairment or disease.

Once your blood lead level climbs above 40 μg/100g, your risk of disease increases. There is a wide variability of individual response to lead, thus it is difficult to say that a particular PbB in a given person will cause a particular effect. Studies have associated fatal encephalopathy with PbBs as low as 150 μg/100g. Other studies have shown other forms of diseases in some workers with PbBs well below 80 μg/100g. Your PbB is a crucial indicator of the risks to your health, but one other factor is also extremely important. This factor is the length of time you have had elevated PbBs. The longer you have an elevated PbB, the greater the risk that large quantities of lead are being gradually stored in your organs and tissues (body burden). The greater your overall body burden, the greater the chances of substantial permanent damage.

The best way to prevent all forms of lead-related impairments and diseases—both short term and long term- is to maintain your PbB below 40 μg/100g. The provisions of the standard are designed with this end in mind. Your employer has prime responsibility to assure that the provisions of the standard are complied with both by the company and by individual workers. You as a worker, however, also have a responsibility to assist your employer in complying with the standard. You can play a key role in protecting your own health by learning about the lead hazards and their control, learning what the standard requires, following the standard where it governs your own actions, and seeing that your employer complies with provisions governing his actions.

(4) *Reporting signs and symptoms of health problems.* You should immediately notify your employer if you develop signs or symptoms associated with lead poisoning or if you desire medical advice concerning the effects of current or past exposure to lead

should also notify your employer if you have difficulty breathing during a respirator fit test or while wearing a respirator. In each of these cases your employer must make available to you appropriate medical examinations or consultations. These must be provided at no cost to you and at a reasonable time and place.

The standard contains a procedure whereby you can obtain a second opinion by a physician of your choice if the employer selected the initial physician.

APPENDIX B TO § 1910.1025—EMPLOYEE STANDARD SUMMARY

This appendix summarizes key provisions of the standard that you as a worker should become familiar with.

I. PERMISSIBLE EXPOSURE LIMIT (PEL)—PARAGRAPH (C)

The standards sets a permissible exposure limit (PEL) of fifty micrograms of lead per cubic meter of air (50 μg/m³), averaged over an 8-hour work-day. This is the highest level of lead in air to which you may be permissibly exposed over an 8-hour workday. Since it is an 8-hour average it permits short exposures above the PEL so long as for each 8-hour work day your average exposure does not exceed the PEL.

This standard recognizes that your daily exposure to lead can extend beyond a typical 8-hour workday as the result of overtime or other alterations in your work schedule. To deal with this, the standard contains a formula which reduces your permissible exposure when you are exposed more than 8 hours. For example, if you are exposed to lead for 10 hours a day, the maximum permitted average exposure would be 40 μg/m³.

II. EXPOSURE MONITORING—PARAGRAPH (D)

If lead is present in the workplace where you work in any quantity, your employer is required to make an initial determination of whether the action level is exceeded for any employee. This initial determination must include instrument monitoring of the air for the presence of lead and must cover the exposure of a representative number of employees who are reasonably believed to have the highest exposure levels. If your employer has conducted appropriate air sampling for lead in the past year he may use these results. If there have been any employee complaints of symptoms which may be attributable to exposure to lead or if there is any other information or observations which would indicate employee exposure to lead, this must also be considered as part of the initial determination. This initial determination must have been completed by March 31, 1979. If this initial determination

that *any* employee may be exposed, without regard to respirators, over the action level (30 μg/m³) your employer must set up an air monitoring program to determine the exposure level of every employee exposed to lead at your workplace.

In carrying out this air monitoring program, your employer is not required to monitor the exposure of every employee, but he must monitor a representative number of employees and job types. Enough sampling must be done to enable each employee's exposure level to be reasonably represented by at least one full shift (at least 7 hours) air sample. In addition, these air samples must be taken under conditions which represent each employee's *regular*, daily exposure to lead. All initial exposure monitoring must have been completed by May 30, 1979.

If you are exposed to lead and air sampling is performed, your employer is required to quickly notify you in writing of air monitoring results which represent your exposure. If the results indicate your exposure exceeds the PEL (without regard to your use of respirators), then your employer must also notify you of this in writing, and provide you with a description of the corrective action that will be taken to reduce your exposure.

Your exposure must be rechecked by monitoring every six months if your exposure is over the action level but below the PEL. Air monitoring must be repeated every 3 months if you are exposed over the PEL. Your employer may discontinue monitoring for you if 2 consecutive measurements, taken at least two weeks apart, are below the action level. However, whenever there is a production, process, control, or personnel change at your workplace which may result in new or additional exposure to lead, or whenever there is any other reason to suspect a change which may result in new or additional exposure to lead, your employer must perform additional monitoring.

III. METHODS OF COMPLIANCE—PARAGRAPH (E)

Your employer is required to assure that no employee is exposed to lead in excess of the PEL. The standard establishes a priority of methods to be used to meet the PEL.

IV. RESPIRATORY PROTECTION—PARAGRAPH (F)

Your employer is required to provide and assure your use of respirators when your exposure to lead is not controlled below the PEL by other means. The employer must pay the cost of the respirator. Whenever you request one, your employer is also required to provide you a respirator even if your air exposure level does not exceed the PEL. You might desire a respirator when, for example, you have received medical advice that your lead absorption should be

dren in the near future, and want to reduce the level of lead in your body to minimize adverse reproductive effects. While respirators are the least satisfactory means of controlling your exposure, they are capable of providing significant protection if properly chosen, fitted, worn, cleaned, maintained, and replaced when they stop providing adequate protection.

Your employer is required to select respirators from the seven types listed in Table II of the Respiratory Protection section of the standard. Any respirator chosen must be approved by the Mine Safety and Health Administration (MSHA) or the National Institute for Occupational Safety and Health (NIOSH). This respirator selection table will enable your employer to choose a type of respirator which will give you a proper amount of protection based on your airborne lead exposure. Your employer may select a type of respirator that provides greater protection than that required by the standard; that is, one recommended for a higher concentration of lead than is present in your workplace. For example, a powered air purifying respirator (PAPR) is much more protective than a typical negative pressure respirator, and may also be more comfortable to wear. A PAPR has a filter, cartridge or canister to clean the air, and a power source which continuously blows filtered air into your breathing zone. Your employer might make a PAPR available to you to ease the burden of having to wear a respirator for long periods of time. The standard provides that you can obtain a PAPR upon request.

Your employer must also start a Respiratory Protection Program. This program must include written procedures for the proper selection, use, cleaning, storage, and maintenance of respirators.

Your employer must assure that your respirator facepiece fits properly. Proper fit of a respirator facepiece is critical. Obtaining a proper fit on each employee may require your employer to make available two or three different mask types. In order to assure that your respirator fits properly and that facepiece leakage is minimized, beginning on November 12, 1982, your employer must give you either a qualitative fit test in accordance with Appendix D of the standard or a quantitative fit test if you use a negative pressure respirator. Any respirator which has a filter, cartridge or canister which cleans the work room air before you breathe it and which requires the force of your inhalation to draw air thru the filtering element is a negative pressure respirator. A positive pressure respirator supplies air to you directly. A quantitative fit test uses a sophisticated machine to measure the amount, if any, of test material that leaks

You must also receive from your employer proper training in the use of respirators. Your employer is required to teach you how to wear a respirator, to know why it is needed, and to understand its limitations.

Until March 1, 1980, your employer must test the effectiveness of your negative pressure respirator initially and at least every six months thereafter with a "qualitative fit test." In this test, the fit of the facepiece is checked by seeing if you can smell a substance placed outside the respirator. If you can, there is appreciable leakage where the facepiece meets your face.

The standard provides that if your respirator uses filter elements, you must be given an opportunity to change the filter elements whenever an increase in breathing resistance is detected. You also must be permitted to periodically leave your work area to wash your face and respirator facepiece whenever necessary to prevent skin irritation. If you ever have difficulty in breathing during a fit test or while using a respirator, your employer must make a medical examination available to you to determine whether you can safely wear a respirator. The result of this examination may be to give you a positive pressure respirator (which reduces breathing resistance) or to provide alternative means of protection.

V. PROTECTIVE WORK CLOTHING AND EQUIPMENT—PARAGRAPH (G)

If you are exposed to lead above the PEL, or if you are exposed to lead compounds such as lead arsenate or lead azide which can cause skin and eye irritation, your employer must provide you with protective work clothing and equipment appropriate for the hazard. If work clothing is provided, it must be provided in a clean and dry condition at least weekly, and daily if your airborne exposure to lead is greater than 200 μg/m³. Appropriate protective work clothing and equipment can include coveralls or similar full-body work clothing, gloves, hats, shoes or disposable shoe coverlets, and face shields or vented goggles. Your employer is required to provide all such equipment at no cost to you. He is responsible for providing repairs and replacement as necessary, and also is responsible for the cleaning, laundering or disposal of protective clothing and equipment. Contaminated work clothing or equipment must be removed in change rooms and not worn home or you will extend your exposure and expose your family since lead from your clothing can accumulate in your house, car, etc. Contaminated clothing which is to be cleaned, laundered or disposed of must be placed in closed containers in the change room. At no time may lead be removed from protective clothing or equipment by any means which

VI. HOUSEKEEPING—PARAGRAPH (H)

Your employer must establish a housekeeping program sufficient to maintain all surfaces as free as practicable of accumulations of lead dust. Vacuuming is the preferred method of meeting this requirement, and the use of compressed air to clean floors and other surfaces is absolutely prohibited. Dry or wet sweeping, shoveling, or brushing may not be used except where vaccuming or other equally effective methods have been tried and do not work. Vacuums must be used and emptied in a manner which minimizes the reentry of lead into the workplace.

VII. HYGIENE FACILITIES AND PRACTICES—PARAGRAPH (I)

The standard requires that change rooms, showers, and filtered air lunchrooms be constructed and made available to workers exposed to lead above the PEL. When the PEL is exceeded the employer must assure that food and beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in these facilities. Change rooms, showers, and lunchrooms, must be used by workers exposed in excess of the PEL. After showering, *no* clothing or equipment worn during the shift may be worn home, and this includes shoes and underwear. Your own clothing worn during the shift should be carried home and cleaned carefully so that it does not contaminate your home. Lunchrooms may not be entered with protective clothing or equipment unless surface dust has been removed by vacuuming, downdraft booth, or other cleaning method. Finally, workers exposed above the PEL must wash both their hands and faces prior to eating, drinking, smoking or applying cosmetics.

All of the facilities and hygiene practices just discussed are essential to minimize additional sources of lead absorption from inhalation or ingestion of lead that may accumulate on you, your clothes, or your possessions. Strict compliance with these provisions can virtually eliminate several sources of lead exposure which significantly contribute to excessive lead absorption.

VIII. MEDICAL SURVEILLANCE—PARAGRAPH (J)

The medical surveillance program is part of the standard's comprehensive approach to the prevention of lead-related disease. Its purpose is to supplement the main thrust of the standard which is aimed at minimizing airborne concentrations of lead and sources of ingestion. Only medical surveillance can determine if the other provisions of the standard have affectively protected you as an individual. Compliance with the standard's provision will protect most workers from the adverse effects of lead exposure,

but may not be satisfactory to protect individual workers (1) who have high body burdens of lead acquired over past years, (2) who have additional uncontrolled sources of non-occupational lead exposure, (3) who exhibit unusual variations in lead absorption rates, or (4) who have specific non-work related medical conditions which could be aggravated by lead exposure (e.g., renal disease, anemia). In addition, control systems may fail, or hygiene and respirator programs may be inadequate. Periodic medical surveillance of individual workers will help detect those failures. Medical surveillance will also be important to protect your reproductive ability—regardless of whether you are a man or woman.

All medical surveillance required by the standard must be performed by or under the supervision of a licensed physician. The employer must provide required medical surveillance without cost to employees and at a reasonable time and place. The standard's medical surveillance program has two parts-periodic biological monitoring and medical examinations.

Your employer's obligation to offer you medical surveillance is triggered by the results of the air monitoring program. Medical surveillance must be made available to all employees who are exposed in excess of the action level for more than 30 days a year. The initial phase of the medical surveillance program, which includes blood lead level tests and medical examinations, must be completed for all covered employees no later than August 28, 1979. Priority within this first round of medical surveillance must be given to employees whom the employer believes to be at greatest risk from continued exposure (for example, those with the longest prior exposure to lead, or those with the highest current exposure). Thereafter, the employer must periodically make medical surveillance—both biological monitoring and medical examinations—available to all covered employees.

Biological monitoring under the standard consists of blood lead level (PbB) and zinc protoporphyrin tests at least every 6 months after the initial PbB test. A zinc protoporphyrin (ZPP) test is a very useful blood test which measures an effect of lead on your body. Thus biological monitoring under the standard is currently limited to PbB testing. If a worker's PbB exceeds 40 μg/100g the monitoring frequency must be increased from every 6 months to at least every 2 months and not reduced until two consecutive PbBs indicate a blood lead level below 40 μg/100g. Each time your PbB is determined to be over 40 μg/100g, your employer must notify you of this in writing within five working days of his receipt of the test results. The employer must also inform you that the standard requires temporary medical removal with economic protection when your PbB exceeds certain criteria. (See Discussion of Medical Removal Protection—Paragraph (k).) During the first year of the standard, this removal criterion is 80 μg/100g. Anytime your PbB exceeds 80 μg/100g your employer must make available to you a prompt follow-up PbB test to ascertain your PbB. If the two tests both exceed 80 μg/100g and you are temporarily removed, then your employer must make successive PbB tests available to you on a monthly basis during the period of your removal.

Medical examinations beyond the initial one must be made available on an annual basis if your blood lead level exceeds 40 μg/100g at any time during the preceding year. The initial examination will provide information to establish a baseline to which subsequent data can be compared. An initial medical examination must also be made available (prior to assignment) for each employee being assigned for the first time to an area where the airborne concentration of lead equals or exceeds the action level. In addition, a medical examination or consultation must be made available as soon as possible if you notify your employer that you are experiencing signs or symptoms commonly associated with lead poisoning or that you have difficulty breathing while wearing a respirator or during a respirator fit test. You must also be provided a medical examination or consultation if you notify your employer that you desire medical advice concerning the effects of current or past exposure to lead on your ability to procreate a healthy child.

Finally, appropriate follow-up medical examinations or consultations may also be provided for employees who have been temporarily removed from exposure under the medical removal protection provisions of the standard. (See Part IX, below.)

The standard specifies the minimum content of pre-assignment and annual medical examinations. The content of other types of medical examinations and consultations is left up to the sound discretion of the examining physician. Pre-assignment and annual medical examinations must include (1) a detailed work history and medical history, (2) a thorough physical examination, and (3) a series of laboratory tests designed to check your blood chemistry and your kidney function. In addition, at any time upon your request, a laboratory evaluation of male fertility will be made (microscopic examination of a sperm sample), or a pregnancy test will be given.

The standard does not require that you participate in any of the medical procedures, tests, etc. which your employer is required to make available to you. Medical surveillance can, however, play a very important role in protecting your health. You

are strongly encouraged, therefore, to participate in a meaningful fashion. The standard contains a multiple physician review mechanism which would give you a chance to have a physician of your choice directly participate in the medical surveillance program. If you were dissatisfied with an examination by a physician chosen by your employer, you could select a second physician to conduct an independent analysis. The two doctors would attempt to resolve any differences of opinion, and select a third physician to resolve any firm dispute. Generally your employer will choose the physician who conducts medical surveillance under the lead standard—unless you and your employer can agree on the choice of a physician or physicians. Some companies and unions have agreed in advance, for example, to use certain independent medical laboratories or panels of physicians. Any of these arrangements are acceptable so long as required medical surveillance is made available to workers.

The standard requires your employer to provide certain information to a physician to aid in his or her examination of you. This information includes (1) the standard and its appendices, (2) a description of your duties as they relate to lead exposure, (3) your exposure level, (4) a description of personal protective equipment you wear, (5) prior blood lead level results, and (6) prior written medical opinions concerning you that the employer has. After a medical examination or consultation the physician must prepare a written report which must contain (1) the physician's opinion as to whether you have any medical condition which places you at increased risk of material impairment to health from exposure to lead, (2) any recommended special protective measures to be provided to you, (3) any blood lead level determinations, and (4) any recommended limitation on your use of respirators. This last element must include a determination of whether you can wear a powered air purifying respirator (PAPR) if you are found unable to wear a negative pressure respirator.

The medical surveillance program of the lead standard may at some point in time serve to notify certain workers that they have acquired a disease or other adverse medical condition as a result of occupational lead exposure. If this is true, these workers might have legal rights to compensation from public agencies, their employers, firms that supply hazardous products to their employers, or other persons. Some states have laws, including worker compensation laws, that disallow a worker who learns of a job-related health impairment to sue, unless the worker sues within a short period of time after learning of the impairment. (This period of time may be a matter of months or years.) An attorney can be consulted about these possibilities. It should be stressed that OSHA is in no way trying to either encourage or discourage claims or lawsuits. However, since results of the standard's medical surveillance program can significantly affect the legal remedies of a worker who has acquired a job-related disease or impairment, it is proper for OSHA to make you aware of this.

The medical surveillance section of the standard also contains provisions dealing with chelation. Chelation is the use of certain drugs (administered in pill form or injected into the body) to reduce the amount of lead absorbed in body tissues. Experience accumulated by the medical and scientific communities has largely confirmed the effectiveness of this type of therapy for the treatment of very severe lead poisoning. On the other hand, it has also been established that there can be a long list of extremely harmful side effects associated with the use of chelating agents. The medical community has balanced the advantages and disadvantages resulting from the use of chelating agents in various circumstances and has established when the use of these agents is acceptable. The standard includes these accepted limitations due to a history of abuse of chelation therapy by some lead companies. The most widely used chelating agents are calcium disodium EDTA, (Ca Na$_2$ EDTA), Calcium Disodium Versenate (Versenate), and d-penicillamine (pencillamine or Cupramine).

The standard prohibits "prophylactic chelation" of any employee by any person the employer retains, supervises or controls. "Prophylactic chelation" is the routine use of chelating or similarly acting drugs to *prevent* elevated blood levels in workers who are occupationally exposed to lead, or the use of these drugs to *routinely* lower blood lead levels to predesignated concentrations believed to be 'safe'. It should be emphasized that where an employer takes a worker who has no symptoms of lead poisoning and has chelation carried out by a physician (either inside or outside of a hospital) solely to reduce the worker's blood lead level, that will generally be considered prophylactic chelation. The use of a hospital and a physician does not mean that prophylactic chelation is not being performed. Routine chelation to prevent increased or reduce current blood lead levels is unacceptable whatever the setting.

The standard allows the use of "therapeutic" or "diagnostic" chelation if administered under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring. Therapeutic chelation responds to severe lead poisoning where there are marked symptoms. Diagnostic chelation involved giving a patient a dose of the drug then collecting all

urine excreted for some period of time as an aid to the diagnosis of lead poisoning.

In cases where the examining physician determines that chelation is appropriate, you must be notified in writing of this fact before such treatment. This will inform you of a potentially harmful treatment, and allow you to obtain a second opinion.

IX. MEDICAL REMOVAL PROTECTION—PARAGRAPH (K)

Excessive lead absorption subjects you to increased risk of disease. Medical removal protection (MRP) is a means of protecting you when, for whatever reasons, other methods, such as engineering controls, work practices, and respirators, have failed to provide the protection you need. MRP involves the temproary removal of a worker from his or her regular job to a place of significantly lower exposure without any loss of earnings, seniority, or other employment rights or benefits. The purpose of this program is to cease further lead absorption and allow your body to naturally excrete lead which has previously been absorbed. Temporary medical removal can result from an elevated blood lead level, or a medical opinion. Up to 18 months of protection is provided as a result of either form of removal. The vast majority of removed workers, however, will return to their former jobs long before this eighteen month period expires. The standard contains special provisions to deal with the extraordinary but possible case where a longterm worker's blood lead level does not adequately decline during eighteen months of removal.

During the first year of the standard, if your blood lead level is 80 μg/100g or above you must be removed from any exposure where your air lead level without a respirator would be 100 μg/m³ or above. If you are removed from your normal job you may not be returned until your blood lead level declines to at least 60 μg/100g. These criteria for removal and return will change according to the following schedule:

	Removal blood lead (μg/100 g)	Air lead (μg/m³)	Return blood lead (μg/100 g)
After Mar. 1, 1980	70 and above	50 and above	At or below 50.
After Mar. 1, 1981	60 and above	30 and above	At or below 40.
After Mar. 1, 1983	50 and above averaged over six months.	30 and above	Do.

You may also be removed from exposure even if your blood lead levels are below these criteria if a final medical determination indicates that you temporarily need reduced lead exposure for medical reasons. If the physician who is implementing your employers medical program makes a final written opinion recommending your removal or other special protective measures, your employer must implement the physician's recommendation. If you are removed in this manner, you may only be returned when the doctor indicates that it is safe for you to do so.

The standard does not give specific instructions dealing with what an employer must do with a removed worker. Your job assignment upon removal is a matter for you, your employer and your union (if any) to work out consistent with existing procedures for job assignments. Each removal must be accomplished in a manner consistent with existing collective bargaining relationships. Your employer is given broad discretion to implement temporary removals so long as no attempt is made to override existing agreements. Similarly, a removed worker is provided no right to veto an employer's choice which satisfies the standard.

In most cases, employers will likely transfer removed employees to other jobs with sufficiently low lead exposure. Alternatively, a worker's hours may be reduced so that the time weighted average exposure is reduced, or he or she may be temporarily laid off if no other alternative is feasible.

In all of these situation, MRP benefits must be provided during the period of removal—i.e., you continue to receive the same earnings, seniority, and other rights and benefits you would have had if you had not been removed. Earnings includes more than just your base wage; it includes overtime, shift differentials, incentives, and other compensation you would have earned if you had not been removed. During the period of removal you must also be provided with appropriate follow-up medical surveillance. If you were removed because your blood lead level was too high, you must be provided with a monthly blood test. If a medical opinion caused your removal, you must be provided medical tests or examinations that the doctor believes to be appropriate. If you do not participate in this follow up medical surveillance, you may lose your eligibility for MRP benefits.

When you are medically eligible to return to your former job, your employer must return you to your "former job status." This means that you are entitled to the position, wages, benefits, etc., you would have had if you had not been removed. If you would

still be in your old job if no removal had occurred that is where you go back. If not, you are returned consistent with whatever job assignment discretion your employer would have had if no removal had occurred. MRP only seeks to maintain your rights, not expand them or diminish them.

If you are removed under MRP and you are also eligible for worker compensation or other compensation for lost wages, your employer's MRP benefits obligation is reduced by the amount that you *actually* receive from these other sources. This is also true if you obtain other employment during the time you are laid off with MRP benefits.

The standard also covers situations where an employer *voluntarily* removes a worker from exposure to lead due to the effects of lead on the employee's medical condition, even though the standard does not require removal. In these situations MRP benefits must still be provided as though the standard required removal. Finally, it is important to note that in all cases where removal is required, respirators cannot be used as a substitute. Respirators may be used before removal becomes necessary, but not as an alternative to a transfer to a low exposure job, or to a lay-off with MRP benefits.

X. EMPLOYEE INFORMATION AND TRAINING—PARAGRAPH (I)

Your employer is required to provide an information and training program for all employees exposed to lead above the action level or who may suffer skin or eye irritation from lead. This program must inform these employees of the specific hazards associated with their work environment, protective measures which can be taken, the danger of lead to their bodies (including their reproductive systems), and their rights under the standard. In addition your employer must make readily available to all employees, including those exposed below the action level, a copy of the standard and its appendices and must distribute to all employees any materials provided to the employer by the Occupational Safety and Health Administration (OSHA).

Your employer is required to complete this training program for all employees by August 28, 1979. After this date, all new employees must be trained prior to initial assignment to areas where there is a possibility of exposure over the action level.

This training program must also be provided at least annually thereafter.

XI. SIGNS—PARAGRAPH (M)

The standard requires that the following warning sign be posted in work areas where

WARNING

LEAD WORK AREA

NO SMOKING OR EATING

XII. RECORDKEEPING—PARAGRAPH (N)

Your employer is required to keep all records of exposure monitoring for airborne lead. These records must include the name and job classification of employees measured, details of the sampling and analytic techniques, the results of this sampling, and the type of respiratory protection being worn by the person sampled. Your employer is also required to keep all records of biological monitoring and medical examination results. These must include the names of the employees, the physician's written opinion, and a copy of the results of the examination. All of the above kinds of records must be kept for 40 years, or for at least 20 years after your termination of employment, whichever is longer.

Recordkeeping is also required if you are temporarily removed from your job under the medical removal protection program. This record must include your name and social security number, the date of your removal and return, how the removal was or is being accomplished, and whether or not the reason for the removal was an elevated blood lead level. Your employer is required to keep each medical removal record only for as long as the duration of an employee's employment.

The standard requires that if you request to see or copy environmental monitoring, blood lead level monitoring, or medical removal records, they must be made available to you or to a representative that you authorize. Your union also has access to these records. Medical records other than PbB's must also be provided upon request to you, to your physician or to any other person whom you may specifically designate. Your union does not have access to your personal medical records unless you authorize their access.

XIII. OBSERVATIONS OF MONITORING—PARAGRAPH (O)

When air monitoring for lead is performed at your workplace as required by this standard, your employer must allow you or someone you designate to act as an observer of the monitoring. Observers are entitled to an explanation of the measurement procedure, and to record the results obtained. Since results will not normally be available at the time of the monitoring, observers are entitled to record or receive the results of the monitoring when returned by the laboratory. Your employer is required

protective devices required to be worn by employees working in the area that is being monitored. The employer must require the observer to wear all such equipment and to comply with all other applicable safety and health procedures.

XIV. EFFECTIVE DATE—PARAGRAPH (P)

The standard's effective data is March 1, 1979, and employer obligations under the standard begin to come into effect as of that date.

XV. FOR ADDITIONAL INFORMATION

A. Copies of the Standard and explanatory materials can be obtained free of charge by calling or writing the OSHA Office of Publications, Room S-1212, United States Department of Labor, Washington, D.C. 20210: Telephone (202) 523-6138. The following publications are available:

1. The standard and summary of the statement of reasons (preamble), FEDERAL REGISTER, Volume 43, pp. 52952-53014, November 14, 1978.
2. The full statement of reasons (preamble) FEDERAL REGISTER, vol. 43, pp. 54354-54509, November 21, 1978.
3. Partial Administrative Stay and Corrections to the standard, (44 FR 5446-5448) January 26, 1979.
4. Notice of the Partial Judicial Stay (44 FR 14554-14555) March 13, 1979.
5. Corrections to the preamble, FEDERAL REGISTER, vol. 44, pp. 20680-20681, April 6, 1979.
6. Additional correction to the preamble concerning the construction industry, FEDERAL REGISTER, vol. 44, p. 50338, August 28, 1979.
7. Appendices to the standard (Appendices A, B, C), FEDERAL REGISTER, Vol. 44, pp. 60980-60995, October 23, 1979.
8. Corrections to appendices, FEDERAL REGISTER, Vol. 44, 68828, November 30, 1979.
9. Revision to the standard and additional appendices (Appendices D and E), FEDERAL REGISTER, Vol. 47, pp. 51117-51119, November 12, 1982.

B. Additional information about the standard, its enforcement, and your employer's compliance can be obtained from the nearest OSHA Area Office listed in your telephone directory under United States Government/Department of Labor.

APPENDIX C TO § 1910.1025—MEDICAL SURVEILLANCE GUIDELINES

INTRODUCTION

The primary purpose of the Occupational Safety and Health Act of 1970 is to assure, so far as possible, safe and healthful working conditions for every working man and

for inorganic lead[1] was promulgated to protect workers exposed to inorganic lead including metallic lead, all inorganic lead compounds and organic lead soaps.

Under this final standard in effect as of March 1, 1979, occupational exposure to inorganic lead is to be limited to 50 $\mu g/m^3$ (micrograms per cubic meter) based on an 8 hour time-weighted average (TWA). This level of exposure eventually must be achieved through a combination of engineering, work practice and other administrative controls. Periods of time ranging from 1 to 10 years are provided for different industries to implement these controls. The schedule which is based on individual industry considerations is given in Table 1. Until these controls are in place, respirators must be used to meet the 50 $\mu g/m^3$ exposure limit.

The standard also provides for a program of biological monitoring and medical surveillance for all employees exposed to levels of inorganic lead above the action level of 30 $\mu g/m^3$ (TWA) for more than 30 days per year.

The purpose of this document is to outline the medical surveillance provisions of the standard for inorganic lead, and to provide further information to the physician regarding the examination and evaluation of workers exposed to inorganic lead.

Section 1 provides a detailed description of the monitoring procedure including the required frequency of blood testing for exposed workers, provisions for medical removal protection (MRP), the recommended right of the employee to a second medical opinion, and notification and recordkeeping requirements of the employer. A discussion of the requirements for respirator use and respirator monitoring and OSHA's position on prophylactic chelation therapy are also included in this section.

Section 2 discusses the toxic effects and clinical manifestations of lead poisoning and effects of lead intoxication on enzymatic pathways in heme synthesis. The adverse effects on both male and female reproductive capacity and on the fetus are also discussed.

Section 3 outlines the recommended medical evaluation of the worker exposed to inorganic lead including details of the medical history, physical examination, and recommended laboratory tests, which are based on the toxic effects of lead as discussed in Section 2.

Section 4 provides detailed information concerning the laboratory tests available for

---

[1] The term inorganic lead used throughout the medical surveillance appendices is meant to be synonymous with the definition

the monitoring of exposed workers. Included also is a discussion of the relative value of each test and the limitations and precautions which are necessary in the interpretation of the laboratory results.

TABLE 1

Permissible airborne lead levels by industry ($\mu g/m^3$)[1]	Effective date					
	Mar. 1, 1979	Mar. 1, 1980	Mar. 1, 1981	Mar. 1, 1982	Mar. 1, 1984	Mar. 1, 1989 (final)
1. Primary lead production	200	200	200	100	100	50
2. Secondary lead production	200	200	200	100	50	50
3. Lead-acid battery manufacturing	200	200	100	100	50	50
4. Nonferrous foundries	200	100	100	100	50	50
5. Lead pigment manufacturing	200	200	200	100	50	50
6. All other industries	200	50	50	50	50	50

[1] Airborne levels to be achieved without reliance or respirator protection through a combination of engineering, work practice and other administrative controls. While these controls are being implemented respirators must be used to meet the 50 $\mu g/m^3$ exposure limit.

I. MEDICAL SURVEILLANCE AND MONITORING REQUIREMENTS FOR WORKERS EXPOSED TO INORGANIC LEAD

Under the occupational health standard for inorganic lead, a program of biological monitoring and medical surveillance is to be made available to all employees exposed to lead above the action level of 30 $\mu g/m^3$ TWA for more than 30 days each year. This program consists of periodic blood sampling and medical evaluation to be performed on a schedule which is defined by previous laboratory results, worker complaints or concerns, and the clinical assessment of the examining physician.

Under this program, the blood lead level of all employees who are exposed to lead above the action level of 30 $\mu g/m^3$ is to be determined at least every six months. The frequency is increased to every two months for employees whose last blood lead level was between 40 μg/100 g whole blood and the level requiring employee medical removal to be discussed below. For employees who are removed from exposure to lead due to an elevated blood lead, a new blood lead level must be measured monthly. A zinc protoporphyrin (ZPP) measurement is strongly recommended on each occasion that a blood lead level measurement is made.

An annual medical examination and consultation performed under the guidelines discussed in Section 3 is to be made available to each employee for whom a blood test conducted at any time during the preceding 12 months indicated a blood lead level at or above 40 μg/100 g. Also, an examination is to be given to all employees prior to their assignment to an area in which airborne lead concentrations reach or exceed the action level. In addition, a medical examination must be provided as soon as possible after notification by an employee that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice regarding lead exposure and the ability to procreate a healthy child, or that the employee has demonstrated difficulty in breathing during a respirator fitting test or during respirator use. An examination is also to be made available to each employee removed from exposure to lead due to a risk of sustaining material impairment to health, or otherwise limited or specially protected pursuant to medical recommendations.

Results of biological monitoring or the recommendations of an examining physician may necessitate removal of an employee from further lead exposure pursuant to the standard's medical removal protection (MRP) program. The object of the MRP program is to provide temporary medical removal to workers either with substantially elevated blood lead levels or otherwise at risk of sustaining material health impairment from continued substantial exposure to lead. The following guidelines which are summarized in Table 2 were created under the standard for the temporary removal of an exposed employee and his or her subsequent return to work in an exposure area.

TABLE 2

	Effective date				
	Mar. 1, 1979	Mar. 1, 1980	Mar. 1, 1981	Mar. 1, 1982	Mar. 1, 1983 (final)
A. Blood lead level requiring employee medical removal. (Level must be confirmed with second follow-up blood lead level within two weeks of first report.).	≥80 μg/100 g	≥70μg/100 g	≥60 μg/100 g	≥60 μg/100 g	≥60μg/100 g or average of last three blood samples or all blood samples over previous 6 months (whichever is over a longer time period) is 50 μg/100 g or greater unless last blood sample is 40 μg/100 g or less.
B. Frequency which employees exposed to action level of lead (30 $\mu g/m^3$ TWA) must have blood lead level checked (ZPP is also strongly recommended in each occasion that a blood lead is obtained.):					
1. Last blood lead level less than 40 μg/100 g	Every 6 months	Every 8 months	Every 6 months	Every 6 months	Every 6 months.
2. Last blood lead level between 40 μg/100 g and level requiring medical removal (see A above).	Every 2 months	Every 2 months	Every 2 months	Every 2 months	Every 2 months.
3. Employees removed from exposure to lead because of an elevated blood lead level.	Every 1 month	Every 1 month	Every 1 month	Every 1 month	Every 1 month.
C. Permissible airborne exposure limit for workers removed from work due to an elevated blood lead level (without regard to respirator protection).	100 $\mu g/m^3$ 8 hr TWA.	50 $\mu g/m^3$ 8 hr TWA.	30 $\mu g/m^3$ 8 hr TWA.	30 $\mu g/m^3$ 8 hr TWA.	30 $\mu g/m^3$ 8 hr TWA.
D. Blood lead level confirmed with a second blood analysis, at which employee may return to work. Permissible exposure without regard to respirator protection is listed by industry in Table I.	<60 μg/100 g	<50 μg/100 g	<40 μg/100 g	<40 μg/100 g	<40 μg/100 g.

NOTE: When medical opinion indicates that an employee is at risk of material impairment from exposure to lead, the physician can remove an employee from exposures exceeding the action level (or less) or recommend special protective measures as deemed appropriate and necessary. Medical monitoring during the medical removal period can be more stringent than noted in the table above if the physician so specifies. Return to work or removal of limitations and special protections is permitted when the physician indicates that the worker is no longer at risk of material impairment.

Under the standard's ultimate worker removal criteria, a worker is to be removed from any work having any eight hour TWA exposure to lead of 30 $\mu g/m^3$ or more whenever either of the following circumstances apply: (1) a blood lead level of 60 $\mu g/100$ g or greater is obtained and confirmed by a second follow-up blood lead level performed within two weeks after the employer receives the results of the first blood sampling test, or (2) the average of the previous three blood lead determinations or the average of all blood lead determinations conducted during the previous six months, whichever encompasses the longest time period, equals or exceeds 50 $\mu g/100$ g, unless the last blood sample indicates a blood lead level at or below 40 $\mu g/100$ g in which case the employee need not be removed. Medical removal is to continue until two consecutive blood lead levels are 40 $\mu g/100$ g or less.

During the first two years that the ultimate removal criteria are being phased in, the return criteria have been set to assure that a worker's blood lead level has substantially declined during the period of removal. From March 1, 1979 to March 1, 1980, the blood lead level requiring employee medical removal is 80 $\mu g/100$ g. Workers found to have a confirmed blood lead at this level or greater need only be removed from work having a daily 8 hour TWA exposure to lead at or above 100 $\mu g/m^3$. Workers so removed are to be returned to work when their blood lead levels are at or below 60 $\mu g/100$ g of whole blood. From March 1, 1980 to March 1, 1981, the blood lead level requiring medical removal is 70 $\mu g/100$ g. During this period workers need only be removed from jobs having a daily 8 hour TWA exposure to lead at or above 50 $\mu g/m^3$ and are to be returned to work when a level of 50 $\mu g/100$ g is achieved. Beginning March 1, 1981, return depends on a worker's blood lead level declining to 40 $\mu g/100$ g of whole blood.

As part of the standard, the employer is required to notify in writing each employee whose blood lead level exceeds 40 $\mu g/100$ g. In addition each such employee is to be informed that the standard requires medical removal with MRP benefits, discussed below, when an employee's blood lead level exceeds the above defined limits.

In addition to the above blood lead level criteria, temporary worker removal may also take place as a result of medical determinations and recommendations. Written medical opinions must be prepared after each examination pursuant to the standard. If the examining physician includes a medical finding, determination or opinion that the employee has a medical condition which places the employee at increased risk of material health impairment from exposure to lead, then the employee must be removed from exposure to lead at or above the action level. Alternatively, if the examining physician recommends special protective measures for an employee (e.g., use of a powered air purifying respirator) or recommends limitations on an employee's exposure to lead, then the employer must implement these recommendations. Recommendations may be more stringent than the specific provisions of the standard. The examining physician, therefore, is given broad flexibility to tailor special protective procedures to the needs of individual employees. This flexibility extends to the evaluation and management of pregnant workers and male and female workers who are planning to raise children. Based on the history, physical examination, and laboratory studies, the physician might recommend special protective measures or medical removal for an employee who is pregnant or who is planning to conceive a child when, in the physician's judgment, continued exposure to lead at the current job would pose a significant risk. The return of the employee to his or her former job status, or the removal of special protections or limitations, depends upon the examining physician determining that the employee is no longer at increased risk of material impairment or that special measures are no longer needed.

During the period of any form of special protection or removal, the employer must maintain the worker's earnings, seniority, and other employment rights and benefits (as though the worker had not been removed) for a period of up to 18 months. This economic protection will maximize meaningful worker participation in the medical surveillance program, and is appropriate as part of the employer's overall obligation to provide a safe and healthful workplace. The provisions of MRP benefits during the employee's removal period may, however, be conditioned upon participation in medical surveillance.

On rare occasions, an employee's blood lead level may not acceptably decline within 18 months of removal. This situation will arise only in unusual circumstances, thus the standard relies on an individual medical examination to determine how to protect such an employee. This medical determination is to be based on both laboratory values, including lead levels, zinc protoporphyrin levels, blood counts, and other tests felt to be warranted, as well as the physician's judgment that any symptoms or findings on physical examination are a result of lead toxicity. The medical determination may be that the employee is incapable of ever safely returning to his or her former job status. The medical determination may provide additional removal time past 18 months for some employees or specify special protective measures to be implemented.

The lead standard provides for a multiple physician review in cases where the employee wishes a second opinion concerning potential lead poisoning or toxicity. If an employee wishes a second opinion, he or she can make an appointment with a physician of his or her choice. This second physician will review the findings, recommendations or determinations of the first physician and conduct any examinations, consultations or tests deemed necessary in an attempt to make a final medical determination. If the first and second physicians do not agree in their assessment they must try to resolve their differences. If they cannot reach an agreement then they must designate a third physician to resolve the dispute.

The employer must provide examining and consulting physicians with the following specific information: a copy of the lead regulations and all appendices, a description of the employee's duties as related to exposure, the exposure level to lead and any other toxic substances (if applicable), a description of personal protective equipment used, blood lead levels, and all prior written medical opinions regarding the employee in the employer's possession or control. The employer must also obtain from the physician and provide the employee with a written medical opinion containing blood lead levels, the physicians's opinion as to whether the employee is at risk of material impairment to health, any recommended protective measures for the employee if further exposure is permitted, as well as any recommended limitations upon an employee's use of respirators.

Employers must instruct each physician not to reveal to the employer in writing or in any other way his or her findings, laboratory results, or diagnoses which are felt to be unrelated to occupational lead exposure. They must also instruct each physician to advise the employee of any occupationally or non-occupationally related medical condition requiring further treatment or evaluation.

The standard provides for the use of respirators where engineering and other primary controls have not been fully implemented. However, the use of respirator protection shall not be used in lieu of temporary medical removal due to elevated blood lead levels or findings that an employee is at risk of material health impairment. This is based on the numerous inadequacies of respirators including skin rash where the facepiece makes contact with the skin, unacceptable stress to breathing in some workers with underlying cardiopulmonary impairment, difficulty in providing adequate fit, the tendency for respirators to create additional hazards by interfering with vision, hearing, and mobility, and the difficulties of assuring the maximum effectiveness of a complicated work practice program involving respirators. Respirators do, however, serve a useful function where engineering and work practice controls are inadequate by providing supplementary, interim, or short-term protection, provided they are properly selected for the environment in which the employee will be working, properly fitted to the employee, maintained and cleaned periodically, and worn by the employee when required.

In its final standard on occupational exposure to inorganic lead, OSHA has prohibited prophylactic chelation. Diagnostic and therapeutic chelation are permitted only under the supervision of a licensed physician with appropriate medical monitoring in an acceptable clinical setting. The decision to initiate chelation therapy must be made on an individual basis and take into account the severity of symptoms felt to be a result of lead toxicity along with blood lead levels, ZPP levels, and other laboratory tests as appropriate. EDTA and penicillamine which are the primary chelating agents used in the therapy of occupational lead poisoning have significant potential side effects and their use must be justified on the basis of expected benefits to the worker. Unless frank and severe symptoms are present, therapeutic chelation is not recommended given the opportunity to remove a worker from exposure and allow the body to naturally excrete accumulated lead. As a diagnostic aid, the chelation mobilization test using CA-EDTA has limited applicability. According to some investigators, the test can differentiate between lead-induced and other nephropathies. The test may also provide an estimation of the mobile fraction of the total body lead burden.

Employers are required to assure that accurate records are maintained on exposure monitoring, medical surveillance, and medical removal for each employee. Exposure monitoring and medical surveillance records must be kept for 40 years or the duration of employment plus 20 years, whichever is longer, while medical removal records must be maintained for the duration of employment. All records required under the standard must be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health and the Director of the National Institute for Occupational Safety and Health. Employers must also make environmental and biological monitoring and medical removal records available to affected employees and to former employees or their authorized employee representatives. Employees or their specifically designated representatives have access to their entire medical surveillance records.

In addition, the standard requires that the employer inform all workers exposed to lead at or above the action level of the provisions of the standard and all its appendices, the purpose and description of medical surveillance and provisions for medical re-

moval protection if temporary removal is required. An understanding of the potential health effects of lead exposure by all exposed employees along with full understanding of their rights under the lead standard is essential for an effective monitoring program.

II. ADVERSE HEALTH EFFECTS OF INORGANIC LEAD

Although the toxicity of lead has been known for 2,000 years, the knowledge of the complex relationship between lead exposure and human response is still being refined. Significant research into the toxic properties of lead continues throughout the world, and it should be anticipated that our understanding of thresholds of effects and margins of safety will be improved in future years. The provisions of the lead standard are founded on two prime medical judgments: first, the prevention of adverse health effects from exposure to lead throughout a working lifetime requires that worker blood lead levels be maintained at or below 40 µg/100 g and second, the blood lead levels of workers, male or female, who intend to parent in the near future should be maintained below 30 µg/100 g to minimize adverse reproductive health effects to the parents and developing fetus. The adverse effects of lead on reproduction are being actively researched and OSHA encourages the physician to remain abreast of recent developments in the area to best advise pregnant workers or workers planning to conceive children.

The spectrum of health effects caused by lead exposure can be subdivided into five developmental stages: normal, physiological changes of uncertain significance, pathophysiological changes, overt symptoms (morbidity), and mortality. Within this process there are no sharp distinctions, but rather a continuum of effects. Boundaries between categories overlap due to the wide variation of individual responses and exposures in the working population. OSHA's development of the lead standard focused on pathophysiological changes as well as later stages of disease.

1. *Heme Synthesis Inhibition.* The earliest demonstrated effect of lead involves its ability to inhibit at least two enzymes of the heme synthesis pathway at very low blood levels. Inhibition of delta aminolevulinic acid dehydrase (ALA-D) which catalyzes the conversion of delta-aminolevulinic acid (ALA) to protoporphyrin is observed at a blood lead level below 20 µg/100 g whole blood. At a blood lead level of 40 ug/100 g, more than 20% of the population would have 70% inhibition of ALA-D. There is an exponential increase in ALA excretion at blood lead levels greater than 40 µg/100 g.

Another enzyme, ferrochelatase, is also inhibited at low blood lead levels. Inhibition of ferrochelatase leads to increased free erythrocyte protoporphyrin (FEP) in the blood which can then bind to zinc to yield zinc protoporphyrin. At a blood lead level of 50 µg/100 g or greater, nearly 100% of the population will have an increase in FEP. There is also an exponential relationship between blood lead levels greater than 40 µg/100 g and the associated ZPP level, which has led to the development of the ZPP screening test for lead exposure.

While the significance of these effects is subject to debate, it is OSHA's position that these enzyme disturbances are early stages of a disease process which may eventually result in the clinical symptoms of lead poisoning. Whether or not the effects do progress to the later stages of clinical disease, disruption of these enzyme processes over a working lifetime is considered to be a material impairment of health.

One of the eventual results of lead-induced inhibition of enzymes in the heme synthesis pathway is anemia which can be asymptomatic if mild but associated with a wide array of symptoms including dizziness, fatigue, and tachycardia when more severe. Studies have indicated that lead levels as low as 50 µg/100 g can be associated with a definite decreased hemoglobin, although most cases of lead-induced anemia, as well as shortened red-cell survival times, occur at lead levels exceeding 80 µg/100 g. Inhibited hemoglobin synthesis is more common in chronic cases whereas shortened erythrocyte life span is more common in acute cases.

In lead-induced anemias, there is usually a reticulocytosis along with the presence of basophilic stippling, and ringed sideroblasts, although none of the above are pathognomonic for lead-induced anemia.

2. *Neurological Effects.* Inorganic lead has been found to have toxic effects on both the central and peripheral nervous systems. The earliest stages of lead-induced central nervous system effects first manifest themselves in the form of behavioral disturbances and central nervous system symptoms including irritability, restlessness, insomnia and other sleep disturbances, fatigue, vertigo, headache, poor memory, tremor, depression, and apathy. With more severe exposure, symptoms can progress to drowsiness, stupor, hallucinations, delerium, convulsions and coma.

The most severe and acute form of lead poisoning which usually follows ingestion or inhalation of large amounts of lead is acute encephalopathy which may arise precipitously with the onset of intractable seizures, coma, cardiorespiratory arrest, and death within 48 hours.

While there is disagreement about what exposure levels are needed to produce the earliest symptoms, most experts agree that symptoms definitely can occur at blood lead levels of 60 µg/100 g whole blood and therefore recommend a 40 µg/100 g maximum. The central nervous system effects frequently are not reversible following discontinued exposure or chelation therapy and when improvement does occur, it is almost always only partial.

The peripheral neuropathy resulting from lead exposure characteristically involves only motor function with minimal sensory damage and has a marked predilection for the extensor muscles of the most active extremity. The peripheral neuropathy can occur with varying degrees of severity. The earliest and mildest form which can be detected in workers with blood lead levels as low as 50 µg/100 g is manifested by slowing of motor nerve conduction velocity often without clinical symptoms. With progression of the neuropathy there is development of painless extensor muscle weakness usually involving the extensor muscles of the fingers and hand in the most active upper extremity, followed in severe cases by wrist drop or, much less commonly, foot drop.

In addition to slowing of nerve conduction, electromyographical studies in patients with blood lead levels greater than 50 µg/100 g have demonstrated a decrease in the number of acting motor unit potentials, an increase in the duration of motor unit potentials, and spontaneous pathological activity including fibrillations and fasciculations. Whether these effects occur at levels of 40 µg/100 g is undetermined.

While the peripheral neuropathies can occasionally be reversed with therapy, again such recovery is not assured particularly in the more severe neuropathies and often improvement is only partial. The lack of reversibility is felt to be due in part to segmental demyelination.

3. *Gastrointestinal.* Lead may also affect the gastrointestinal system producing abdominal colic or diffuse abdominal pain, constipation, obstipation, diarrhea, anorexia, nausea and vomiting. Lead colic rarely develops at blood lead levels below 80 µg/100 g.

4. *Renal.* Renal toxicity represents one of the most serious health effects of lead poisoning. In the early stages of disease nuclear inclusion bodies can frequently be identified in proximal renal tubular cells. Renal function remains normal and the changes in this stage are probably reversible. With more advanced disease there is progressive interstitial fibrosis and impaired renal function. Eventually extensive interstitial fibrosis ensues with sclerotic glomeruli and dilated and atrophied proximal tubules; all represent end stage kidney disease. Azotemia can be progressive, eventually resulting in frank uremia necessitating dialysis. There is occasionally associated hypertension and hyperuricemia with or without gout.

Early kidney disease is difficult to detect. The urinalysis is normal in early lead nephropathy and the blood urea nitrogen and serum creatinine increase only when two-thirds of kidney function is lost. Measurement of creatinine clearance can often detect earlier disease as can other methods of measurement of glomerular filtration rate. An abnormal Ca-EDTA mobilization test has been used to differentiate between lead-induced and other nephropathies, but this procedure is not widely accepted. A form of Fanconi syndrome with aminoaciduria, glycosuria, and hyperphosphaturia indicating severe injury to the proximal renal tubules is occasionally seen in children.

5. *Reproductive effects.* Exposure to lead can have serious effects on reproductive function in both males and females. In male workers exposed to lead there can be a decrease in sexual drive, impotence, decreased ability to produce healthy sperm, and sterility. Malformed sperm (teratospermia), decreased number of sperm (hypospermia), and sperm with decreased motility (asthenospermia) can all occur. Teratospermia has been noted at mean blood lead levels of 53 µg/100 g and hypospermia and asthenospermia at 41 µg/100 g. Furthermore, there appears to be a dose-response relationship for teratospermia in lead exposed workers.

Women exposed to lead may experience menstrual disturbances including dysmenorrhea, menorrhagia and amenorrhea. Following exposure to lead, women have a higher frequency of sterility, premature births, spontaneous miscarriages, and stillbirths.

Germ cells can be affected by lead and cause genetic damage in the egg or sperm cells before conception and result in failure to implant, miscarriage, stillbirth, or birth defects.

Infants of mothers with lead poisoning have a higher mortality during the first year and suffer from lowered birth weights, slower growth, and nervous system disorders.

Lead can pass through the placental barrier and lead levels in the mother's blood are comparable to concentrations of lead in the umbilical cord at birth. Transplacental passage becomes detectable at 12-14 weeks of gestation and increases until birth.

There is little direct data on damage to the fetus from exposure to lead but it is generally assumed that the fetus and newborn would be at least as susceptible to neurological damage as young children. Blood lead levels of 50-60 µg/100 g in children can cause significant neurobehavioral impairments and there is evidence of hyperactivity

at blood levels as low as 25 μg/100 g. Given the overall body of literature concerning the adverse health effects of lead in children, OSHA feels that the blood lead level in children should be maintained below 30 μg/100 g with a population mean of 15 μg/100 g. Blood lead levels in the fetus and newborn likewise should not exceed 30 μg/100 g.

Because of lead's ability to pass through the placental barrier and also because of the demonstrated adverse effects of lead on reproductive function in both the male and female as well as the risk of genetic damage of lead on both the ovum and sperm, OSHA recommends a 30 μg/100 g maximum permissible blood lead level in both males and females who wish to bear children.

6. *Other toxic effects.* Debate and research continue on the effects of lead on the human body. Hypertension has frequently been noted in occupationally exposed individuals although it is difficult to assess whether this is due to lead's adverse effects on the kidney or if some other mechanism is involved. Vascular and electrocardiogarphic changes have been detected but have not been well characterized. Lead is thought to impair thyroid function and interfere with the pituitary-adrenal axis, but again these effects have not been well defined.

III. MEDICAL EVALUATION

The most important principle in evaluating a worker for any occupational disease including lead poisoning is a high index of suspicion on the part of the examining physician. As discussed in Section 2, lead can affect numerous organ systems and produce a wide array of signs and symptoms, most of which are non-specific and subtle in nature at least in the early stages of disease. Unless serious concern for lead toxicity is present, many of the early clues to diagnosis may easily be overlooked.

The crucial initial step in the medical evaluation is recognizing that a worker's employment can result in exposure to lead. The worker will frequently be able to define exposures to lead and lead containing materials but often will not volunteer this information unless specifically asked. In other situations the worker may not know of any exposures to lead but the suspicion might be raised on the part of the physician because of the industry or occupation of the worker. Potential occupational exposure to lead and its compounds occur in at least 120 occupations, including lead smelting, the manufacture of lead storage batteries, the manufacture of lead pigments and products containing pigments, solder manufacture, shipbuilding and ship repair, auto manufacturing, construction, and painting.

Once the possibility for lead exposure is raised, the focus can then be directed toward eliciting information from the medical history, physical exam, and finally from laboratory data to evaluate the worker for potential lead toxicity.

A complete and detailed work history is important in the initial evaluation. A listing of all previous employment with information on work processes, exposure to fumes or dust, known exposures to lead or other toxic substances, respiratory protection used, and previous medical surveillance should all be included in the worker's record. Where exposure to lead is suspected, information concerning on-the-job personal hygiene, smoking or eating habits in work areas, laundry procedures, and use of any protective clothing or respiratory protection equipment should be noted. A complete work history is essential in the medical evaluation of a worker with suspected lead toxicity, especially when long term effects such as neurotoxicity and nephrotoxicity are considered.

The medical history is also of fundamental importance and should include a listing of all past and current medical conditions, current medications including proprietary drug intake, previous surgeries and hospitalizations, allergies, smoking history, alcohol consumption, and also non-occupational lead exposures such as hobbies (hunting, riflery). Also known childhood exposures should be elicited. Any previous history of hematological, neurological, gastrointestinal, renal, psychological, gynecological, genetic, or reproductive problems should be specifically noted.

A careful and complete review of systems must be performed to assess both recognized complaints and subtle or slowly acquired symptoms which the worker might not appreciate as being significant. The review of symptoms should include the following:

General—weight loss, fatigue, decreased appetite.

Head, Eyes, Ears, Nose, Throat (HEENT)—headaches, visual disturbances or decreased visual acuity, hearing deficits or tinnitus, pigmentation of the oral mucosa, or metallic taste in mouth.

Cardio-pulmonary—shortness of breath, cough, chest pains, palpitations, or orthopnea.

Gastrointestinal—nausea, vomiting, heartburn, abdominal pain, constipation or diarrhea.

Neurologic—irritability, insomnia, weakness (fatigue), dizziness, loss of memory, confusion, hallucinations, incoordination, ataxia, decreased strength in hands or feet, disturbances in gait, difficulty in climbing stairs, or seizures.

Hematologic—pallor, easy fatigability, abnormal blood loss, melena.

Reproductive (male and female and spouse where relevant)—history of infertility, impotence, loss of libido, abnormal menstrual periods, history of miscarriages, stillbirths, or children with birth defects.

Musculo-skeletal—muscle and joint pains.

The physical examination should emphasize the neurological, gastrointestinal, and cardiovascular systems. The worker's weight and blood pressure should be recorded and the oral mucosa checked for pigmentation characteristic of a possible Burtonian or lead line on the gingiva. It should be noted, however, that the lead line may not be present even in severe lead poisoning if good oral hygiene is practiced.

The presence of pallor on skin examination may indicate an anemia, which if severe might also be associated with a tachycardia. If an anemia is suspected, an active search for blood loss should be undertaken including potential blood loss through the gastrointestinal tract.

A complete neurological examination should include an adequate mental status evaluation including a search for behavioral and psychological disturbances, memory testing, evaluation for irritability, insomnia, hallucinations, and mental clouding. Gait and coordination should be examined along with close observation for tremor. A detailed evaluation of peripheral nerve function including careful sensory and motor function testing is warranted. Strength testing particularly of extensor muscle groups of all extremities is of fundamental importance.

Cranial nerve evaluation should also be included in the routine examination.

The abdominal examination should include auscultation for bowel sounds and abdominal bruits and palpation for organomegaly, masses, and diffuse abdominal tenderness.

Cardiovascular examination should evaluate possible early signs of congestive heart failure. Pulmonary status should be addressed particularly if respirator protection is contemplated.

As part of the medical evaluation, the lead standard requires the following laboratory studies:

1. Blood lead level
2. Hemoglobin and hematocrit determinations, red cell indices, and examination of the peripheral blood smear to evaluate red blood cell morphology
3. Blood urea nitrogen
4. Serum creatinine
5. Routine urinalysis with microscopic examination.
6. A zinc protoporphyrin level

In addition to the above, the physician is authorized to order any further laboratory or other tests which he or she deems necessary in accordance with sound medical practice. The evaluation must also include pregnancy testing or laboratory evaluation of male fertility if requested by the employee.

Additional tests which are probably not warranted on a routine basis but may be appropriate when blood lead and ZPP levels are equivocal include delta aminolevulinic acid and coproporphyrin concentrations in the urine, and dark-field illumination for detection of basophilic stippling in red blood cells.

If an anemia is detected further studies including a careful examination of the peripheral smear, reticulocyte count, stool for occult blood, serum iron, total iron binding capacity, bilirubin, and, if appropriate, vitamin B12 and folate may be of value in attempting to identify the cause of the anemia.

If a peripheral neuropathy is suspected, nerve conduction studies are warranted both for diagnosis and as a basis to monitor any therapy.

If renal disease is questioned, a 24 hour urine collection for creatinine clearance, protein, and electrolytes may be indicated. Elevated uric acid levels may result from lead-induced renal disease and a serum uric acid level might be performed.

An electrocardiogram and chest x-ray may be obtained as deemed appropriate.

Sophisticated and highly specialized testing should not be done routinely and where indicated should be under the direction of a specialist.

IV. LABORATORY EVALUATION

The blood lead level at present remains the single most important test to monitor lead exposure and is the test used in the medical surveillance program under the lead standard to guide employee medical removal. The ZPP has several advantages over the blood lead level. Because of its relatively recent development and the lack of extensive data concerning its interpretation, the ZPP currently remains an ancillary test.

This section will discuss the blood lead level and ZPP in detail and will outline their relative advantages and disadvantages. Other blood tests currently available to evaluate lead exposure will also be reviewed.

The blood lead level is a good index of current or recent lead absorption when there is no anemia present and when the worker has not taken any chelating agents. However, blood lead levels along with urinary lead levels do not necessarily indicate the total body burden of lead and are not adequate measures of past exposure. One reason for this is that lead has a high affinity for bone and up to 90% of the body's total lead is deposited there. A very important component of the total lead body burden is lead in soft tissue (liver, kidney, and brain). This fraction of the lead body burden, the biologically active lead, is not entirely reflected by blood lead levels since it is a function of the dynamics of lead ab-

sorption, distribution, deposition in bone and excretion. Following discontinuation of exposure to lead, the excess body burden is only slowly mobilized from bone and other relatively stable body stores and excreted. Consequently, a high blood lead level may only represent recent heavy exposure to lead without a significant total body excess and likewise a low blood lead level does not exclude an elevated total body burden of lead.

Also due to its correlation with recent exposures, the blood lead level may vary considerably over short time intervals.

To minimize laboratory error and erroneous results due to contamination, blood specimens must be carefully collected after thorough cleaning of the skin with appropriate methods using lead-free blood containers and analyzed by a reliable laboratory. Under the standard, samples must be analyzed in laboratories which are approved by the Center for Disease Control (CDC) or which have received satisfactory grades in proficiency testing by the CDC in the previous year. Analysis is to be made using atomic absorption spectrophotometry, anodic stripping voltammetry or any method which meets the accuracy requirements set forth by the standard.

The determination of lead in urine is generally considered a less reliable monitoring technique than analysis of whole blood primarily due to individual variability in urinary excretion capacity as well as the technical difficulty of obtaining accurate 24 hour urine collections. In addition, workers with renal insufficiency, whether due to lead or some other cause, may have decreased lead clearance and consequently urine lead levels may underestimate the true lead burden. Therefore, urine lead levels should not be used as a routine test.

The zinc protoporphyrin test, unlike the blood lead determination, measures an adverse metabolic effect of lead and as such is a better indicator of lead toxicity than the level of blood lead itself. The level of ZPP reflects lead absorption over the preceding 3 to 4 months, and therefore is a better indicator of lead body burden. The ZPP requires more time than the blood lead to read significantly elevated levels; the return to normal after discontinuing lead exposure is also slower. Furthermore, the ZPP test is simpler, faster, and less expensive to perform and no contamination is possible. Many investigators believe it is the most reliable means of monitoring chronic lead absorption.

Zinc protoporphyrin results from the inhibition of the enzyme ferrochelatase which catalyzes the insertion of an iron molecule into the protoporphyrin molecule, which then becomes heme. If iron is not inserted into the molecule then zinc, having a greater affinity for protoporphyrin, takes the place of the iron, forming ZPP.

An elevation in the level of circulating ZPP may occur at blood lead levels as low as 20-30 μg/100 g in some workers. Once the blood lead level has reached 40 μg/100 g there is more marked rise in the ZPP value from its normal range of less than 100 μg/100 ml. Increases in blood lead levels beyond 40 μg/100 g are associated with exponential increases in ZPP.

Whereas blood lead levels fluctuate over short time spans, ZPP levels remain relatively stable. ZPP is measured directly in red blood cells and is present for the cell's entire 120 day life-span. Therefore, the ZPP level in blood reflects the average ZPP production over the previous 3-4 months and consequently the average lead exposure during that time interval.

It is recommended that a hematocrit be determined whenever a confirmed ZPP of 50 μg/100 ml whole blood is obtained to rule out a significant underlying anemia. If the ZPP is in excess of 100 μg/100 ml and not associated with abnormal elevations in blood lead levels, the laboratory should be checked to be sure that blood leads were determined using atomic absorption spectrophotometry anodic stripping voltammetry, or any method which meets the accuracy requirements set forth by the standard by a CDC approved laboratory which is experienced in lead level determinations. Repeat periodic blood lead studies should be obtained in all individuals with elevated ZPP levels to be certain that an associated elevated blood lead level has not been missed due to transient fluctuations in blood leads.

ZPP has a characteristic fluorescence spectrum with a peak at 594 nm which is detectable with a hematofluorimeter. The hematofluorimeter is accurate and portable and can provide on-site, instantaneous results for workers who can be frequently tested via a finger prick.

However, careful attention must be given to calibration and quality control procedures. Limited data on blood lead—ZPP correlations and the ZPP levels which are associated with the adverse health effects discussed in Section 2 are the major limitations of the test. Also it is difficult to correlate ZPP levels with environmental exposure and there is some variation of response with age and sex. Nevertheless, the ZPP promises to be an important diagnostic test for the early detection of lead toxicity and its value will increase as more data is collected regarding its relationship to other manifestations of lead poisoning.

Levels of delta-aminolevulinic acid (ALA) in the urine are also used as a measure of lead exposure. Increasing concentrations of ALA are believed to result from the inhibition of the enzyme delta-aminolevulinic acid dehydrase (ALA-D). Although the test is relatively easy to perform, inexpensive, and rapid, the disadvantages include variability in results, the necessity to collect a complete 24 hour urine sample which has a specific gravity greater than 1.010, and also the fact that ALA decomposes in the presence of light.

The pattern of porphyrin excretion in the urine can also be helpful in identifying lead intoxication. With lead poisoning, the urine concentrations of coproporphyrins I and II, porphobilinogen and uroporphyrin I rise. The most important increase, however, is that of coproporphyrin III; levels may exceed 5,000 μg/l in the urine in lead poisoned individuals, but its correlation with blood lead levels and ZPP are not as good as those of ALA. Increases in urinary porphyrins are not diagnostic of lead toxicity and may be seen in porphyria, some liver diseases, and in patients with high reticulocyte counts.

Summary. The Occupational Safety and Health Administration's standard for inorganic lead places significant emphasis on the medical surveillance of all workers exposed to levels of inorganic lead above the action level of 30 μg/m³ TWA. The physician has a fundamental role in this surveillance program, and in the operation of the medical removal protection program.

Even with adequate worker education on the adverse health effects of lead and appropriate training in work practices, personal hygiene and other control measures, the physician has a primary responsibility for evaluating potential lead toxicity in the worker. It is only through a careful and detailed medical and work history, a complete physical examination and appropriate laboratory testing that an accurate assessment can be made. Many of the adverse health effects of lead toxicity are either irreversible or only partially reversible and therefore early detection of disease is very important.

This document outlines the medical monitoring program as defined by the occupational safety and health standard for inorganic lead. It reviews the adverse health effects of lead poisoning and describes the important elements of the history and physical examinations as they relate to these adverse effects. Finally, the appropriate laboratory testing for evaluating lead exposure and toxicity is presented.

It is hoped that this review and discussion will give the physician a better understanding of the OSHA standard with the ultimate goal of protecting the health and well-being of the worker exposed to lead under his or her care.

APPENDIX D TO § 1910.1025—QUALITATIVE FIT TEST PROTOCOLS

This appendix specifies the only allowable qualitative fit test protocols permissible for compliance with paragraph (f)(3)(ii).

I. ISOAMYL ACETATE PROTOCOL

A. Odor threshold screening.

1. Three 1-liter glass jars with metal lids (e.g. Mason or Bell jars) are required.

2. Odor-free water (e.g. distilled or spring water) at approximately 25°C shall be used for the solutions.

3. The isoamyl acetate (IAA) (also known as isopentyl acetate) stock solution is prepared by adding 1 cc of pure IAA to 800 cc of odor free water in a 1-liter jar and shaking for 30 seconds. This solution shall be prepared new at least weekly.

4. The screening test shall be conducted in a room separate from the room used for actual fit testing. The two rooms shall be well ventilated but may not be connected to the same recirculating ventilation system.

5. The odor test solution is prepared in a second jar by placing. .4 cc of the stock solution into 500 cc of odor free water using a clean dropper or pipette. Shake for 30 seconds and allow to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution may be used for only one day.

6. A test blank is prepared in a third jar by adding 500 cc of odor free water.

7. The odor test and test blank jars shall be labelled 1 and 2 for jar identification. If the labels are put on the lids they can be periodically *dried off* and switched to avoid people thinking the same jar always has the IAA.

8. The following instructions shall be typed on a card and placed on the table in front of the two test jars (i.e. 1 and 2);

"The purpose of this test is to determine if you can smell banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contains a small amount of banana oil. Be sure the covers are on tight, then shake each bottle for two seconds. Unscrew the lid of each bottle, one at a time, and sniff at the mouth of the bottle. Indicate to the test conductor which bottle contains banana oil."

9. The mixtures used in the IAA odor detection test shall be prepared in an area separate from where the test is performed, in order to prevent olfactory fatigue in the subject.

10. If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA QLFT may not be used.

11. If the test subject correctly identifies

may proceed to respirator selection and fit testing.

B. Respirator selection.

1. The test subject shall be allowed to select the most comfortable respirator from a large array of various sizes and manufacturers that includes at least three sizes of elastomeric half facepieces and units of at least two manufacturers.

2. The selection process shall be conducted in a room separate from the fit-test chamber to prevent odor fatigue. Prior to the selection process, the test subject shall be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension and how to assess an "comfortable" respirator. A mirror shall be available to assist the subject in evaluating the fit and positioning of the respirator. This may not constitute his formal training on respirator use, only a review.

3. The test subject should understand that he is being asked to select the respirator which provides the most comfortable fit for him. Each respirator represents a different size and shape and, if fit properly, will provide adequate protection.

4. The test subject holds each facepiece up to his face and eliminates those which are obviously not giving a comfortable fit. Normally, selection will begin with a half-mask and if a fit cannot be found here, the subject will be asked to go to the full facepiece respirators. (A small percentage of users will not be able to wear any half-mask.)

5. The more comfortable facepieces are recorded; the most comfortable mask is donned and *worn at least five minutes* to assess comfort. Assistance in assessing comfort can be given by discussing the points in #6 below. If the test subject is not familiar with using a particular respirator, he shall be directed to don the mask several times and to adjust the straps each time, so that he becomes adept at setting proper tension on the straps.

6. Assessment of comfort shall include reviewing the following points with the test subject:

- Chin properly placed.
- Positioning of mask on nose.
- Strap tension.
- Fit across nose bridge.
- Room for safety glasses.
- Distance from nose to chin.
- Room to talk.
- Tendency to slip.
- Cheeks filled out.
- Self-observation in mirror.
- Adequate time for assessment.

7. The test subject shall conduct the conventional negative and positive-pressure fit checks (e.g. see ANSI Z88.2-1980). Before conducting the negative- or positive-pressure checks, the subject shall be told to

side-to-side and up and down, taking a few deep breaths.

8. The test subject is now ready for fit testing.

9. After passing the fit test, the test subject shall be questioned again regarding the comfort of the respirator. If it has become uncomfortable, another model of respirator shall be tried.

10. The employee shall be given the opportunity to select a different facepiece and be retested if during the first two weeks of on-the-job wear the chosen facepiece becomes unacceptably uncomfortable.

C. Fit test.

1. The fit test chamber shall be substantially similar to a clear 55 gallon drum liner suspended inverted over a 2 foot diameter frame, so that the top of chamber is about 6 inches above the test subject's head. The inside top center of the chamber shall have a small hook attached.

2. Each respirator used for the fitting and fit testing shall be equipped with organic vapor cartridges or offer protection against organic vapors. The cartridges or masks shall be changed at least weekly.

3. After selecting, donning, and properly adjusting a respirator himself, the test subject shall wear it to the fit testing room. This room shall be separate from the room used for odor threshold screening and respirator selection, and shall be well ventilated, as by an exhaust fan or lab hook, to prevent general room contamination.

4. A copy of the following test exercises and rainbow (or equally effective) passage shall be taped to the inside of the test chamber:

Test Exercises

i. Normal breathing.

ii. Deep breathing. Be certain breaths are *deep* and *regular*.

iii. Turning head from side-to-side. Be certain movement is complete. Alert the test subject not to bump the respirator on the shoulders. Have the test subject inhale when his head is at either side.

iv. Nodding head up-and-down. Be certain motions are complete and made about every second. Alert the test subject not bump the respirator on the chest. Have the test subject inhale when his head is in the fully up position.

v. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading it will result in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages which serve the same purpose may also be used.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

vi. Normal breathing.

5. Each test subject shall wear his respirator for at least 10 minutes before starting the fit test.

6. Upon entering the test chamber, the test subject shall be given a 6 inch by 5 inch piece of paper towel or other porous absorbent single ply material, folded in half and wetted with three-quarters of one cc of pure IAA. The test subject shall hang the wet towel on the hook at the top of the chamber.

7. Allow two minutes for the IAA test concentration to be reached before starting the fit-test exercises. This would be an appropriate time to talk with the test subject, to explain the fit test, the importance of his cooperation, the purpose for the head exercises, or to demonstrate some of the exercises.

8. Each exercise described in No. 4 above shall be performed for at least one minute.

9. If at any time during the test, the subject detects the banana-like odor of IAA, he shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.

10. Upon returning to the selection room, the subject shall remove the respirator, repeat the odor sensitivity test, select and put on another respirator, return to the test chamber, etc. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait about 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

11. If a person cannot be fitted with the selection of half-mask respirators, include full facepiece models in the selection process. When a respirator is found that passes the test, its efficiency shall be demonstrated for the subject by having him break the face seal and take a breath before exiting the chamber.

12. When the test subject leaves the chamber he shall remove the saturated towel, returning it to the test conductor. To keep the area from becoming contaminated, the used towels shall be kept in a self-sealing bag. There is no significant IAA concentration buildup in the test chamber from

13. Persons who have successfully passed this fit test may be assigned the use of the tested respirator in atmospheres with up to 10 times the PEL of airborne lead. In other words this IAA protocol may be used to assign a protection factor no higher than 10.

II. SACCHARIN SOLUTION AEROSOL PROTOCOL

A. Taste threshold screening.

1. Threshold screening as well as fit testing employees shall use an enclosure about the head and shoulders that is approximately 12 inches in diameter by 14 inches tall with at least the front portion clear and that allows free movement of the head when a respirator is worn. An enclosure substantially similar to the 3M hood assembly of part # FT 14 and FT 15 combined is adequate.

2. The test enclosure shall have a three-quarter inch hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

3. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

4. The test subject shall don the test enclosure. For the threshold screening test, he shall breath through his open mouth with tongue extended.

5. Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the threshold check solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

6. The threshold check solution consists of 0.83 grams of sodium saccharin, USP in water. It can be prepared by putting 1 cc of the test solution (see C6 below) in 100 cc of water.

7. To produce the aerosol, the nebulizer bulb is firmly squeezed so that it collapses completely then released and allowed to fully expand.

8. Ten squeezes are repeated rapidly and then the test subject is asked whether the saccharin can be tasted.

9. If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

10. If the second response is negative ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

11. The test conductor will take note of the number of squeezes required to elicit a taste response.

12. If the saccharin is not tasted after 30 squeezes (Step 9), the test subject may not perform the saccharin fit test.

13. If a taste response is elicited, the test subject shall be asked to take note of the

14. Correct use of the nebulizer means that approximately 1 cc of liquid is used at a time in the nebulizer body.

15. The nebulizer shall be thoroughly rinsed in water, shaken dry, and refilled at least each morning and afternoon or at least every four hours.

B. Respirator selection.

Respirators shall be selected as described in section IB above, except that each respirator shall be equipped with a particulate filter cartridge.

C. Fit test.

1. The fit test uses the same enclosure described in B1 and B2 above

2. Each test subject shall wear his respirator for at least 10 minutes before starting the fit test.

3. The test subject shall don the enclosure while wearing the respirator selected in section A above. This respirator shall be properly adjusted and equipped with a particulate filter cartridge.

4. The test subject may not eat, drink (except plain water), or chew gum for 15 minutes before the test.

5. A second DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.

6. The fit test solution is prepared by adding 83 grams of sodium saccharin to 100 cc of warm water.

7. As before, the test subject shall breathe through the open mouth with tongue extended.

8. The nebulizer is inserted into the hole in the front of the enclosure and the fit test solution is sprayed into the enclosure and the fit test solution is sprayed into the enclosure using the same technique as for the taste threshold screening and the same number of squeezes required to elicit a taste response in the screening. (See B 10 above).

9. After generation of the aerosol the test subject shall be instructed to perform the following exercises for one minute each.

i. Normal breathing.

ii. Deep breathing. Be certain breaths are *deep* and *regular.*

iii. Turning head from side-to-side. Be certain movement is complete. Alert the test subject not to bump the respirator on the shoulders. Have the test subject inhale when his head is at either side.

iv. Nodding head up-and-down. Be certain motions are complete. Alert the test subject not to bump the respirator on the chest. Have the test subject inhale when his head in the fully up position.

v. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading it will result in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages which serve the same purpose may also be used.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

10. Every 30 seconds, the aerosol concentration shall be replenished using one-half the number of squeeze as initially (C8).

11. The test subject shall so indicate to the test conductor if at any time during the fit test the taste of saccharin is detected.

12. If the saccharin is detected the fit is deemed unsatisfactory and a different respirator shall be tried.

13. Successful completion of the test protocol shall allow the use of the tested respirator in contaminated atmospheres up to 10 times the PEL. In other words this protocol may be used assign protection factors no higher than ten.

III. IRRITANT FUME PROTOCOL

A. Respirator selection.

Respirators shall be selected as described in section IB above, except that each respirator shall be equipped with high efficiency cartridges.

B. Fit test.

1. The test subject shall be allowed to smell a weak concentration of the irritant smoke to familiarize him with the characteristic odor of each.

2. The test subject shall properly don the respirator selected as above, and wear it for at least 10 minutes before starting the fit test.

3. The test conductor shall review this protocol with the test subject before testing.

4. The test subject shall perform the conventional positive pressure and negative pressure fit checks. Failure of either check shall be cause to select an alternate respirator.

5. Break both ends of a ventilation smoke tube containing stannic oxychloride, such as the MSA part No. 5645, or equivalent. Attach a short length of tubing to one end of the smoke tube. Attach the other end of the smoke tube to a low pressure air pump set to deliver 200 milliliters per minute.

6. Advise the test subject that the smoke can be irritating to the eyes and instruct him to keep his eyes closed while the test is performed.

7. The test conductor shall direct the stream of irritant smoke from the tube towards the faceseal area of the test subject. He shall begin at least 12 inches from the facepiece and gradually move to within one inch, moving around the whole perimeter of the mask.

8. The following exercises shall be performed while the respirator seal is being challenged by the smoke. Each shall be performed for one minute.

i. Normal breathing.

ii. Deep breathing. Be certain breaths are *deep* and *regular.*

iii. Turning head from side-to-side. Be certain movement is complete. Alert the test subject not to bump the respirator on the shoulders. Have test subject inhale when his head is at either side.

iv. Nodding head up-and-down. Be certain motions are complete. Alert the test subject not to bump the respirator on the chest. Have the test subject inhale when his head is in the fully up position.

v. Talking—slowly and distinctly, count backwards from 100.

vi. Normal breathing.

9. If the irritant smoke produces an involuntary reaction (cough) by the test subject, the test conductor shall stop the test. In this case the tested respirator is rejected and another respirator shall be selected.

10. Each test subject passing the smoke test without evidence of a response shall be given a sensitivity check of the smoke from the same tube to determine whether he reacts to the smoke. Failure to evoke a response shall void the fit test.

11. Steps B4, B7, B8 of this protocol shall be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the irritant smoke.

12. Respirators successfully tested by the protocol may be used in contaminated atmospheres up to ten times the PEL. In other words this protocol may be used to assign protection factors not exceeding ten.

[43 FR 53007, Nov. 14, 1978]

EDITORIAL NOTE: For FEDERAL REGISTER citations affecting § 1910.1025 see the List of CFR Sections Affected in the Finding Aids section of this volume.

§ 1910.1028 Benzene.

~~(a) *Scope and application.* (1) This section applies to all occupational exposures to benzene. Chemical Abstracts Service Registry No. 71-43-2, except as provided in paragraphs (a)(2) and (a)(3) of this section.~~

~~(2) This section does not apply to:~~

~~(i) The storage, transportation, distribution, dispensing, sale or use of gasoline, motor fuels, or other fuels containing benzene subsequent to its final discharge from bulk wholesale storage facilities, except that operations where gasoline or motor fuels are dispensed for more than 4 hours per day in an indoor location are covered by this section.~~

~~(ii) Loading and unloading operations at bulk wholesale storage facilities which use vapor control systems for all loading and unloading operations, except for the provisions of 29 CFR 1910.1200 as incorporated into this section and the emergency provisions of paragraphs (g) and (i)(4) of this section.~~

~~(iii) The storage, transportation, distribution or sale of benzene or liquid mixtures containing more than 0.1 percent benzene in intact containers or in transportation pipelines while sealed in such a manner as to contain benzene vapors or liquid, except for the provisions of 29 CFR 1910.1200 as incorporated into this section and the emergency provisions of paragraphs (g) and (i)(4) of this section.~~

~~(iv) Containers and pipelines carrying mixtures with less than 0.1 percent benzene and natural gas processing plants processing gas with less than 0.1 percent benzene.~~

~~(v) Work operations where the only exposure to benzene is from liquid mixtures containing 0.5 percent or less of benzene by volume, or the vapors released from such liquids until September 12, 1988; work operations where the only exposure to benzene is from liquid mixtures containing 0.3 percent or less of benzene by volume or the vapors released from such liquids from September 12, 1988, to September 12, 1989; and work operations where the only exposure to benzene is from liquid mixtures containing 0.1 percent or less of benzene by volume or the vapors released from such liquids after September 12, 1989; except that tire building machine operators using solvents with more than 0.1 percent benzene are covered by paragraph (i) of this section.~~

~~(vi) Oil and gas drilling, production and servicing operations.~~

~~(vii) Coke oven batteries.~~

~~(3) The cleaning and repair of barges and tankers which have contained benzene are excluded from~~

APPENDIX C

Appendix C

DEPARTMENT OF THE NAVY
NAVAL FACILITIES
ENGINEERING COMMAND
GUIDE SPECIFICATION

NFGS-02090
30 June 1991

SECTION TABLE OF CONTENTS

SITE WORK

SECTION 02090

REMOVAL AND DISPOSAL OF LEAD-CONTAINING PAINT

PART 1 GENERAL

- 1.1 SUMMARY
- 1.2 REFERENCES
- 1.3 DEFINITIONS
    - 1.3.1 Action Level
    - 1.3.2 Area Monitoring
    - 1.3.3 Physical Boundary
    - 1.3.4 Certified Industrial Hygienist (CIH)
    - 1.3.5 Change Rooms and Shower Facilities
    - 1.3.6 Decontamination Room
    - 1.3.7 Eight-Hour Time Weighted Average (TWA)
    - 1.3.8 High Efficiency Particulate Air (HEPA) Filter Equipment
    - 1.3.9 Lead
    - 1.3.10 Lead Control Area
    - 1.3.11 Lead Permissible Exposure Limit (PEL)
    - 1.3.12 Personal Monitoring
- 1.4 QUALITY ASSURANCE
    - 1.4.1 *Medical Examinations*\
        - 1.4.1.1 Medical Records
    - 1.4.2 CIH Responsibilities
    - 1.4.3 Training
        - 1.4.3.1 *Training Certification*\
    - 1.4.4 Respiratory Protection Program
    - 1.4.5 *Hazard Communication Program*\
    - 1.4.6 Hazardous Waste Management
    - 1.4.7 Safety and Health Compliance
    - 1.4.8 Pre-Construction Conference
- 1.5 SUBMITTALS
    - 1.5.1 *SD-02, Manufacturer's Catalog Data*\
    - 1.5.2 *SD-08, Statements*\
        - 1.5.2.1 *Qualifications of CIH*\
        - 1.5.2.2 *Lead-containing Paint Removal Plan*\
        - 1.5.2.3 Testing Laboratory
    - 1.5.3 *SD-10, Test Reports*\
        - 1.5.3.1 Air Monitoring
    - 1.5.4 *SD-13, Certificates*\
- 1.6 REMOVAL

- 1.6.1 Title to Materials
- 1.7 EQUIPMENT
  - 1.7.1 *Respirators*\
  - 1.7.2 Special Protective Clothing
  - 1.7.3 *Rental Equipment Notification*\
  - 1.7.4 *Vacuum Filters*\

PART 2 PRODUCTS

- 2.1 PAINT REMOVAL PRODUCTS
- 2.2 Abrasive Materials
  - 2.2.1 Limits on the Composition of Abrasive Materials

PART 3 EXECUTION

- 3.1 PROTECTION
  - 3.1.1 Notification
  - 3.1.2 Lead Control Area Requirements
  - 3.1.3 Protection of Existing Work to Remain
  - 3.1.4 Boundary Requirements
  - 3.1.5 Furnishings
  - 3.1.6 Heating, Ventilating and Air Conditioning (HVAC) Systems
  - 3.1.7 Change Room and Shower Facilities
  - 3.1.8 Mechanical Ventilation System
  - 3.1.9 Personnel Protection
  - 3.1.10 Warning Signs
- 3.2 WORK PROCEDURES
  - 3.2.1 Personnel Exiting Procedures
  - 3.2.2 Monitoring
    - 3.2.2.1 Monitoring During Paint Removal Work
- 3.3 LEAD-CONTAINING PAINT REMOVAL
  - 3.3.1 Indoor Lead Paint Removal
    - 3.3.1.1 Selection
    - 3.3.1.2 Mechanical Paint Removal and Blast Cleaning
  - 3.3.2 Outdoor Lead Paint Removal
    - 3.3.2.1 Selection
- 3.4 SURFACE PREPARATIONS
- 3.5 CLEANUP AND DISPOSAL
  - 3.5.1 Cleanup
  - 3.5.2 Certification
  - 3.5.3 Testing of Lead-Containing Paint Residue [and Used Abrasive]
  - 3.5.4 Disposal
  - 3.5.5 Disposal Documentation
  - 3.5.6 Payment for Hazardous Waste

-- End of Table of Contents --

DEPARTMENT OF THE NAVY
NAVAL FACILITIES
ENGINEERING COMMAND
GUIDE SPECIFICATION

NFGS-02090
30 June 1991

NFGS-02090

REMOVAL AND DISPOSAL OF LEAD-CONTAINING PAINT

Preparing Activity: PACNAVFACENGCOM

	Typed Name & Reg.	Signature	Date
Prepared by:	G. T. AOKI, P.E.	G. T. Aoki	5/28/91
Approved by:	W. T. TAKUSHI, P.E. Branch Manager	W. T. Takushi	5/30/91
Approved by:	for ERIK T. TAKAI, P.E. Division Director		5/30/91
Approved for NAVFAC:	Carl E. Kersten, R.A.	Carl Kersten	06/30/91

AMSC N/A

AREA FACR

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

****
DEPARTMENT OF THE NAVY
NAVAL FACILITIES
ENGINEERING COMMAND
GUIDE SPECIFICATION

NFGS-02090
30 June 1991
****

SECTION 02090

REMOVAL AND DISPOSAL OF LEAD-CONTAINING PAINT
06/91

****
NOTE: This interim guide specification covers the \@requirements and procedures for limiting occupational and environmental exposure to lead when removing lead-containing paint. This guide specification is intended for use in projects where lead-containing paints must be removed from painted surfaces and it has been determined that the lead-containing paint is classified as hazardous waste in accordance with 40 CFR 261, Identification and Listing of Hazardous Waste, thereby requiring special handling, storage, and disposal according to federal and local hazardous waste management regulations@\.
****

****
NOTE: Obtain from the activities information on lead-containing paint in paint removal and disposal projects. This will require testing of paint to be removed in accordance with 40 CFR 261.
****

****
NOTE: Projects that involve cutting, sawing, etc., of lead-containing painted materials may result in lead exposures in excess of OSHA limits. If so, personal protective equipment should be used and controls implemented. Obtain recommendations from cognizant industrial hygienist on health and safety measures.
****

PART 1 GENERAL

1.1 SUMMARY

****
NOTE: The article "Summary" is not used by the Naval Facilities Engineering Command, except in specialized cases. Delete this article when editing for project specifications.
****

****

NOTE: Indicate on the project drawings:

1. Lead control area (area of lead-containing paint to be removed).

2. Designated boundary (area around lead control area).

****

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

\-ANSI Z9.2-\	1979 Fundamentals Governing the Design and Operation of Local Exhaust Systems
\-ANSI Z88.2-\	1980 Respiratory Protection

CODE OF FEDERAL REGULATIONS (CFR)

\-29 CFR 1910.134-\	1988 Respiratory Protection
\-29 CFR 1910.1025-\	1988 Lead
\-29 CFR 1910.1200-\	1988 Hazard Communication
\-29 CFR 1926.55-\	Gases, Vapors, Fumes, Ducts, and Mists
\-29 CFR 1926.57-\	Ventilation
\-40 CFR 260-\	Hazardous Waste Management System: General
\-40 CFR 261-\	Identification and Listing of Hazardous Waste
\-40 CFR 262-\	Generators of Hazardous Waste
\-40 CFR 263-\	Transporters of Hazardous Waste
\-40 CFR 264-\	Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
\-40 CFR 265-\	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
\-40 CFR 268-\	1989 Land Disposal Restrictions

\-49 CFR 172-\	Hazardous Materials Tables and Hazardous Materials Communications Regulations
\-49 CFR 178-\	Shipping Container Specifications

MILITARY SPECIFICATIONS (MIL)

\-MIL-A-22262-\	(Rev. A) (Am. 2) Abrasive Blasting Media Ship Hull Blast Cleaning

UNDERWRITERS LABORATORIES INC. (UL)

\-UL 586-\	1985 (R 1988) High-Efficiency, Particulate, Air Filter Units, Sixth Edition

1.3 DEFINITIONS

1.3.1 Action Level

Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8-hour period. As used in this section, "30 micrograms per cubic meter of air" refers to the action level.

1.3.2 Area Monitoring

Sampling of lead concentrations within the lead control area and inside the physical boundaries which is representative of the airborne lead concentrations which may reach the breathing zone of personnel potentially exposed to lead.

1.3.3 Physical Boundary

Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean the same as "outside lead control area."

1.3.4 Certified Industrial Hygienist (CIH)

As used in this section, refers to an Industrial Hygienist employed by the Contractor and is certified by the American Board of Industrial Hygiene in comprehensive practice.

1.3.5 Change Rooms and Shower Facilities

Rooms within the designated physical boundary around the lead control area equipped with separate storage facilities for clean protective work clothing and equipment and for street clothes which prevent cross-contamination.

1.3.6 Decontamination Room

Room for removal of contaminated personal protective equipment (PPE).

1.3.7 Eight-Hour Time Weighted Average (TWA)

Airborne concentration of lead averaged over an 8-hour workday to which an employee is exposed.

1.3.8 High Efficiency Particulate Air (HEPA) Filter Equipment

HEPA filtered vacuuming equipment with a \-UL 586-\ filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron size particles.

1.3.9 Lead

Metallic lead, inorganic lead compounds, and organic lead soaps. Excluded from this definition are other organic lead compounds.

1.3.10 Lead Control Area

An enclosed area or structure with full containment to prevent the spread of lead dust, paint chips, or debris of lead-containing paint removal operations. The lead control area is isolated by physical boundaries to prevent unauthorized entry of personnel.

1.3.11 Lead Permissible Exposure Limit (PEL)

Fifty micrograms per cubic meter of air as an 8-hour time weighted average as determined by \-29 CFR 1910.1025-\. If an employee is exposed for more than 8 hours in a work day, the PEL shall be determined by the following formula:

PEL (micrograms/cubic meter of air) = 400/No. hrs worked per day

1.3.12 Personal Monitoring

Sampling of lead concentrations within the breathing zone of an employee to determine the 8-hour time weighted average concentration in accordance with \-29 CFR 1910.1025-\. Samples shall be representative of the employee's work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches and the center at the nose or mouth of an employee.

1.4 QUALITY ASSURANCE

1.4.1 *Medical Examinations*\

Before exposure to lead-contaminated dust, provide workers with a comprehensive medical examination as required by \-29 CFR 1910.1025-\ and \-29 CFR 1910.1200-\. The examination will not be required if adequate records show that employees have been examined as required by \-29 CFR 1910.1025-\ within the last year.

1.4.1.1 Medical Records

Maintain complete and accurate medical records of employees for a period of at least 40 years or for the duration of employment plus 20 years, whichever is longer.

1.4.2 CIH Responsibilities

a. Certify training.

b. Review and approve lead-containing paint removal plan for conformance to the applicable referenced standards.

c. Inspect lead-containing paint removal work for conformance with the approved plan.

d. Direct monitoring.

e. Ensure work is performed in strict accordance with specifications at all times.

f. Ensure hazardous exposure to personnel and to the environment are adequately controlled at all times.

1.4.3 Training

Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment, in accordance with \-29 CFR 1910.1025-\.

1.4.3.1 *Training Certification*\

Submit certificates signed and dated by the CIH and by each employee stating that the employee has received training.

1.4.4 Respiratory Protection Program

a. Furnish each employee required to wear a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least every 6 months thereafter as required by \-29 CFR 1910.1025-\.

b. Establish and implement a *respiratory protection program*\ as required by \-ANSI Z88.2-\, \-29 CFR 1910.134-\, \-29 CFR 1910.1025-\, and \-29 CFR 1926.55-\.

1.4.5 *Hazard Communication Program*\

Establish and implement a Hazard Communication Program as required by \-29 CFR 1910.1200-\.

1.4.6 Hazardous Waste Management

****

NOTE: Delete this paragraph if the Government is to

dispose of hazardous waste. Verify that Government disposal is available and make arrangements if so.

****

Submit a *Hazardous Waste Management Plan*\ within 45 calendar days after award of contract for Contracting Officer's approval. The Hazardous Waste Management plan shall comply with applicable requirements of federal, state, and local hazardous waste regulations and address:

a. identification of hazardous wastes associated with the work.

b. estimated quantities of wastes to be generated and disposed of.

c. names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and a 24-hour point of contact. Furnish two copies of [EPA] [state] [and] [local] hazardous waste [permit applications] [permits] [and] [EPA Identification numbers].

d. names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.

e. list of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.

f. spill prevention, containment, and cleanup contingency measures to be implemented.

g. work plan and schedule for waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily.

h. cost for hazardous waste disposal according to this plan.

1.4.7 Safety and Health Compliance

****

NOTE: Include applicable state, regional, and local laws, regulations, and statutes.

****

In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of federal, state, and local authorities regarding removing, handling, storing, transporting, and disposing of lead waste materials. Comply with the applicable requirements of the current issue of \-29 CFR 1910.1025-\. Submit matters regarding interpretation of standards to the Contracting Officer for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply. [The following local laws, ordinances, criteria, rules and regulations regarding removing, handling, storing, transporting, and disposing of lead-contaminated materials apply:

a. [_____]

b. [_____]

c. [_____]]

1.4.8 Pre-Construction Conference

Along with the CIH, meet with the Contracting Officer to discuss in detail the lead-containing paint removal *work plan*\, including work procedures and precautions for the work plan.

1.5 SUBMITTALS

****

NOTE: Where a "G" in asterisk tokens follows a submittal item, it indicates Government approval for that item. Add "G" in asterisk tokens following any added or existing submittal items deemed sufficiently critical, complex, or aesthetically significant to merit approval by the Government. Submittal items not designated with a "G" will be approved by the CQC organization.

****

Submit the following in accordance with Section \-01300-\, "Submittals."

1.5.1 *SD-02, Manufacturer's Catalog Data*\

a. *Vacuum filters*\

b. *Respirators*\

c. Paint removal materials and applicable *material safety data sheets*\

1.5.2 *SD-08, Statements*\

a. *Qualifications of CIH*\

b. *Lead-containing paint removal plan*\

c. *Rental equipment notification*\

d. Completed and signed hazardous waste *manifest*\ from treatment or disposal facility

e. CIH approval of *work plan*\ (signature, date, and certification number)

[f. EPA approved hazardous waste treatment or *disposal facility*\ for lead disposal]

[g. *Hazardous waste management plan*\]

h. *Laboratory shall be accredited*\

1.5.2.1 *Qualifications of CIH*\

Submit name, address, and telephone number of the CIH selected to perform responsibilities in paragraph entitled "CIH Responsibilities." Provide previous experience of the CIH. Submit proper documentation that the Industrial Hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification.

1.5.2.2 *Lead-containing Paint Removal Plan*\

Submit a detailed job-specific plan of the work procedures to be used in the removal of lead-containing paint. The plan shall include a sketch showing the location, size, and details of lead control areas, location and details of decontamination rooms, change rooms, shower facilities, and mechanical ventilation system. Include in the plan, eating, drinking, smoking and restroom procedures, interface of trades, sequencing of lead related work, collected wastewater and paint debris disposal plan, air sampling plan, respirators, protective equipment, and a detailed description of the method of containment of the operation to ensure that airborne lead concentrations of 30 micrograms per cubic meter of air are not exceeded outside of the lead control area. Include air sampling, training and strategy, sampling methodology, frequency, duration of sampling, and qualifications of air monitoring personnel in the air sampling portion of the plan. Obtain approval of the plan prior to the start of paint removal work.

1.5.2.3 Testing Laboratory

Submit the name, address, and telephone number of the testing laboratory selected to perform the monitoring, testing, and reporting of airborne concentrations of lead. Provide proper documentation that persons performing the analysis have been judged proficient by successful participation within the last year in the National Institute for Occupational Safety and Health (NIOSH) Proficiency Analytical Testing (PAT) Program. The *laboratory shall be accredited*\ by the American Industrial Hygiene Association (AIHA). Provide AIHA documentation along with date of accreditation/reaccreditation.

1.5.3 *SD-10, Test Reports*\

a. *Monitoring Results*\

1.5.3.1 Air Monitoring

Submit *monitoring results*\ to the Contracting Officer within 3 working days, signed by the testing laboratory employee performing the air monitoring, the employee that analyzed the sample, and the CIH.

1.5.4 *SD-13, Certificates*\

a. *Vacuum filters*\

b. Certification of *medical examinations*\

c. Employee *training certification*\

d. *Respiratory protection program*\

e. *Hazard communication program*\

1.6 REMOVAL

1.6.1 Title to Materials

Materials resulting from demolition work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of in accordance with Section \-02050-\, "Demolition and Removal," except as specified herein.

1.7 EQUIPMENT

****

NOTE: Verify the number of sets required with OICC/ROICC.

****

Furnish the Contracting Officer with [two] [_____] complete sets of personal protective equipment daily, as required herein, for entry into and inspection of the paint removal work within the lead controlled area. Personal protective equipment shall include fitted respirators and disposable whole body covering, including appropriate foot, head, and hand protection. PPE shall remain the property of the Contractor.

1.7.1 *Respirators*\

Furnish appropriate respirators approved by the NIOSH, Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of \-29 CFR 1910.1025-\.

1.7.2 Special Protective Clothing

Furnish personnel who will be exposed to lead-contaminated dust with appropriate disposable protective whole body clothing, head covering, gloves, and foot coverings. Furnish appropriate disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CIH.

1.7.3 *Rental Equipment Notification*\

If rental equipment is to be used during lead-containing paint handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. Furnish a copy of the written notification to the Contracting Officer.

1.7.4 *Vacuum Filters*\

\-UL 586-\ labeled HEPA filters.

PART 2 PRODUCTS

2.1 PAINT REMOVAL PRODUCTS

Submit applicable *Material Safety Data Sheets*\ for paint removal products used in paint removal work. Use the least toxic product [suitable for the job] [acceptable to the Industrial Hygienist].

2.2 Abrasive Materials

****

NOTE: Abrasive blasting is not allowed for Pearl Harbor Naval Shipyard projects.

****

Abrasive blasting materials shall meet the requirements of \-MIL-A-22262-\ for limits on chemical composition and hazardous material ingredients.

2.2.1 Limits on the Composition of Abrasive Materials

The soluble metal content and the total metal content shall not exceed values which would cause a material to be classified as a hazardous waste as specified in \-MIL-A-22262-\.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Notification

\+Notify the Contracting Officer [20] [_____] days prior to the start of any paint removal work.+\

3.1.2 Lead Control Area Requirements

a. Establish a lead control area by completely enclosing with [containment screens] [_____] the area or structure where lead-containing paint removal operations will be performed.

b. Contain removal operations by the use of a negative pressure full containment system with at least one change room and with HEPA filtered exhaust.

3.1.3 Protection of Existing Work to Remain

Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better.

3.1.4 Boundary Requirements

Provide physical boundaries around the lead control area by roping off the area [designated on the plans] or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.

3.1.5 Furnishings

****
NOTE: Verify with the activity furniture/equipment requirements.
****

[The Government will remove furniture and equipment from the work area before lead-containing paint removal work begins.] [Furniture [_____] and equipment will remain in the building. Protect and cover furnishings or remove furnishings from the work area and store in a location approved by the Contracting Officer.]

3.1.6 Heating, Ventilating and Air Conditioning (HVAC) Systems

Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6-mil plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area. [Provide temporary HVAC system for areas in which HVAC has been shut down outside the lead control area.]

3.1.7 Change Room and Shower Facilities

Provide clean change rooms and shower facilities within the physical boundary around the designated lead control area in accordance with requirements of \-29 CFR 1910.1025-\.

3.1.8 Mechanical Ventilation System

****
NOTE: Recirculation of HEPA filtered air from lead operations is not recommended per OPNAVINST 5100.23B, Chapter 3.
****

a. Use adequate ventilation to control personnel exposure to lead in accordance with \-29 CFR 1926.57-\.

b. To the extent feasible, use fixed local exhaust ventilation connected to HEPA filters or other collection systems, approved by the industrial hygienist. Local exhaust ventilation systems shall be designed, constructed, installed, and maintained in accordance with \-ANSI Z9.2-\.

[c. If air from exhaust ventilation is recirculated into the work place, the system shall have a high efficiency filter with reliable back-up filter and controls to monitor the concentration of lead in the return air and to bypass the recirculation system automatically if it fails. Air may be recirculated only where exhaust to the outside is not feasible.]

3.1.9 Personnel Protection

Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been given appropriate training and protective equipment.

3.1.10 Warning Signs

Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of \-29 CFR 1910.1025-\.

3.2 WORK PROCEDURES

Perform removal of lead-containing paint in accordance with approved lead-containing paint removal plan. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead-containing paint is removed in accordance with \-29 CFR 1910.1025-\, except as specified herein. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), federal, state, and local requirements.

3.2.1 Personnel Exiting Procedures

Whenever personnel exit the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:

a. Vacuum themselves off.

b. Remove protective clothing in the decontamination room, and place them in an approved impermeable disposal bag.

c. Shower.

d. Change to clean clothes prior to leaving the physical boundary designated around the lead-contaminated job site.

3.2.2 Monitoring

Monitoring of airborne concentrations of lead shall be in accordance with \-29 CFR 1910.1025-\ and as specified herein. \+Air monitoring, testing, and reporting shall be performed by a CIH or an Industrial Hygiene (IH) Technician who is under the direction of the CIH.+\

****

NOTE: Include the bracketed sentence as necessary for PACNAVFACENGCOM projects.

****

a. The CIH or the IH Technician under the direction of the CIH shall be on the jobsite directing the monitoring, and inspecting the lead-containing paint removal work to ensure that the requirements of the Contract have been satisfied during the entire lead-containing paint removal operation. [The CIH shall be [located on the Island of Oahu] [_____] during the entire lead-containing paint removal operation.]

b. Take personal air monitoring samples on employees who are anticipated to have the greatest risk of exposure as determined by the CIH. In addition, take air monitoring samples on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.

****

NOTE: Take into account the availability and location of adequate laboratory facilities in relation to the location of the job site and the relative exposure risk associated with exceeding the action level at the designated physical boundaries, i.e., a remote fuel storage tank, versus a house exterior in a housing area.

****

c. Submit results of air monitoring samples, signed by the CIH, within [16] [24] [_____] hours after the air samples are taken. Notify the Contracting Officer immediately of exposure to lead at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area.

3.2.2.1 Monitoring During Paint Removal Work

Perform personal and area monitoring during the entire paint removal operation. Sufficient area monitoring shall be conducted at the physical boundary to ensure unprotected personnel are not exposed above 30 micrograms per cubic meter of air at all times. If the outside boundary lead levels are at or exceed 30 micrograms per cubic meter of air, work shall be stopped and the CIH shall immediately correct the condition(s) causing the increased levels and notify the Contracting Officer immediately. The CIH shall review the sampling data collected on that day to determine if condition(s) requires any further change in work methods. Removal work shall resume when approval is given by the CIH. The Contractor shall control the lead level outside of the work boundary to less than 30 micrograms per cubic meter of air at all times. As a minimum, conduct area monitoring daily on each shift in which lead paint removal operations are performed in areas immediately adjacent to the lead control area. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area. If adjacent areas are contaminated, clean and visually inspect contaminated areas. The CIH shall certify that the area has been cleaned of lead contamination.

3.3 LEAD-CONTAINING PAINT REMOVAL

****

NOTE: See Note A located at rear of text.

****

[Manual or power sanding of interior and exterior surfaces is not permitted.] Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions are necessary to minimize damage to the underlying substrate.

3.3.1 Indoor Lead Paint Removal

3.3.1.1 Selection

****

NOTE: See Note B located at rear of text.

****

Select paint removal processes to minimize contamination of work areas with lead-contaminated dust or other lead-contaminated debris/waste. This paint removal process should be described in the lead-containing paint removal plan. [Perform manual sanding and scraping to the maximum extent feasible.]

3.3.1.2 Mechanical Paint Removal and Blast Cleaning

Perform mechanical paint removal and blast cleaning in lead control areas using negative pressure full containments with HEPA filtered exhaust. Collect paint residue and spent grit (used abrasive) from blasting operations for disposal in accordance with EPA, state and local requirements.

3.3.2 Outdoor Lead Paint Removal

****

NOTE: Use on a case-by-case basis after consulting with the local Industrial Hygienist for recommended practices, procedures, and precautions.

****

3.3.2.1 Selection

Select paint removal processes to minimize contamination of work areas with lead-contaminated dust or other lead-contaminated debris/waste. This paint removal process should be described in the lead-containing paint removal plan. [Perform manual sanding and scraping to the maximum extent feasible.]

3.4 SURFACE PREPARATIONS

****

NOTE: Use if paint removal is from metal or concrete surfaces.

****

Avoid flash rusting or other deterioration of the substrate. Provide surface preparations for painting in accordance with Section \-09900-\, "Painting."

3.5 CLEANUP AND DISPOSAL

3.5.1 Cleanup

****

NOTE: Verify with the local Industrial Hygienist if wet mopping of the work area and surfaces is necessary.

****

Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use compressed air to clean up the area. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner [and wet mopping the area].

3.5.2 Certification

The CIH shall certify in writing that the inside and outside the lead control area air monitoring samples are less than 30 micrograms per cubic meter of air, the respiratory protection for the employees was adequate, the work procedures were performed in accordance with \-29 CFR 1910.1025-\, and that there were no visible accumulations of lead-contaminated paint and dust on the worksite. Do not remove the lead control area or roped-off boundary and warning signs prior to the Contracting Officer's receipt of the CIH's certification. Reclean areas showing dust or residual paint chips.

****

NOTE: Add testing if required to be performed by the Contractor.

****

3.5.3 Testing of Lead-Containing Paint Residue [and Used Abrasive]

[Where indicated or when directed by the Contracting Officer,] test lead containing paint residue [and used abrasive] in accordance with \-40 CFR 261-\ for hazardous waste.

3.5.4 Disposal

****

NOTE: Notify the activity that Federal regulations (40 CFR 260-265) require a U.S. EPA generator identification number for use on the Uniform Hazardous Waste Manifest prior to commencement of removal work.

****

****

NOTE: Use this option if transportation and disposal has been arranged with PWD/PWC. Verify procedures with PWD/PWC.

****

****

NOTE: For PACNAVFACENGCOM projects, see Note C at end of text.

****

a. Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing, which may produce airborne concentrations of lead particles.

b. Store removed paint, lead-contaminated clothing and equipment, and lead-contaminated dust and cleaning debris into U.S. Department of Transportation (\-49 CFR 178-\) approved 55-gallon drums. Properly label each drum to identify the type of waste (\-49 CFR 172-\) and the date lead-contaminated wastes were first put into the drum. Obtain and complete the Uniform Hazardous Waste Manifest forms from [Activity Staff Civil Engineer located at [_____]] [_____]. Comply with land disposal restriction notification requirements as required by \-40 CFR 268-\. At least 14 days prior to delivery, notify the Contracting Officer who will arrange for job site inspection of the drums and manifests by [PWC Hazardous Waste Storage Facility personnel] [_____]. As necessary, make lot deliveries of hazardous wastes to the [PWC Hazardous Waste Storage Facility] [_____] to ensure that drums do not remain on the jobsite longer than 90 calendar days from the date affixed to each drum.

****

NOTE: Use this option if the Contractor is to dispose of hazardous waste.

****

****

NOTE: Research state, regional, and local laws, regulations, and statutes and revise the specifications accordingly.

****

a. Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing which may produce airborne concentrations of lead particles. Label the containers in accordance with \-29 CFR 1910.1025-\. Dispose of lead-contaminated waste material at a [EPA] [or] [state] approved hazardous waste treatment, storage, or disposal facility off Government property.

****

NOTE: Hawaii does not have an EPA or State approved hazardous waste landfill.

****

b. Store waste materials in U.S. Department of Transportation (\-49 CFR 178-\) approved 55-gallon drums. Properly label each drum to identify the type of waste (\-49 CFR 172-\) and the date the drum was filled. The Contracting Officer or an authorized representative will assign an area for interim storage of waste-containing drums. Do not store hazardous waste drums in interim storage longer than 90 calendar days from the date affixed to each drum.

c. Handle, store, transport, and dispose lead or lead-contaminated waste in accordance with \-40 CFR 260-\, \-40 CFR 261-\, \-40 CFR 262-\, \-40 CFR 263-\, \-40 CFR 264-\, and \-40 CFR 265-\. Comply with land disposal restriction notification requirements as required by \-40 CFR 268-\.

3.5.5 Disposal Documentation

****

NOTE: Include the following paragraph if the Contractor is to dispose of hazardous waste.

****

Submit written evidence that the hazardous waste treatment, storage, or *disposal facility*\ (TSD) is approved for lead disposal by the EPA and state or local regulatory agencies. Submit one copy of the completed *manifest*\, signed and dated by the initial transporter in accordance with \-40 CFR 262-\.

3.5.6 Payment for Hazardous Waste

Payment for disposal of hazardous waste will not be made until a signed copy of the manifest from the treatment or disposal facility certifying the amount of lead-containing materials delivered is returned and a copy is furnished to the Government.

-- End of Section --

CRITERIA NOTES

NOTE A: Use bracketed prohibition on manual and power sand when appropriate. Large scale manual or power sanding of painted surfaces should never be allowed in family housing, administrative buildings, galleys, barracks, etc., due to problems associated with the resulting dust fallout/contamination of crevices and cracks which may retain unseen quantities of lead-contaminated dust. Use of this type of removal technique for exteriors of the aforementioned facility types should be extremely limited, because the resulting airborne dust could result in significant contamination of the ground in the immediate vicinity of the facility. Manual or power sanding of interior and exterior surfaces may be an acceptable work method only if appropiate controls for personnel/environmental protection are in place.

NOTE B: Listed below are various types of paint removal techniques. Designer may be required to specify a particular technique in order to limit potential conflicts or problems.

1. Wood, Drywall, Interior Partitions

a. Scraping
b. Heat Stripping
c. Chemical Stripping
d. Power Tool Cleaning
e. Wet Abrasive Blasting

2. Steel and Metal Surfaces (Industrial)

a. Power/Hand Tool Cleaning
b. Dry Abrasive Blast with Water Ring (Wet "Halo")
c. Wet Abrasive Blast
d. Low Volume High Pressure Water Blast

NOTE C: Verify and arrange with Disposal Facility (PWC Pearl Harbor Utilities Department or Pearl Harbor Naval Shipyard) prior to specifying hazardous waste disposal by the Government.

1. PWC Pearl Harbor Disposal: Manifest forms are obtained from Naval Station Port Services located at Building 150, Naval Station, Pearl Harbor. PWC Hazardous Waste Storage Facility is located at Building 530, Naval Supply Center, Pearl Harbor.

2. Pearl Harbor Naval Shipyard Disposal: Manifest forms are obtained from Shipyard Code 308.12 located at Building 327, Pearl Harbor Naval Shipyard, Pearl Harbor. Shipyard Hazardous Waste Storage "Area" is

located at the C and D Lot, Pearl Harbor Naval Shipyard, Pearl Harbor. Consult Pearl Harbor Naval Shipyard for additional information.

NOTE D: Suggestions for improvement of this specification will be welcomed using the "Agency Response Form" located in SPECSINTACT under "System Directory" or DD Form 1426. Suggestions should be forwarded to:

Commanding Officer
Naval Construction Battalion Center
Civil Engineer Support Office
Code DS03
Port Hueneme, CA 93043-5000

-- End --

****
DEPARTMENT OF THE NAVY GENERAL NOTES (July 1991)
NAVAL FACILITIES
ENGINEERING COMMAND
****

GENERAL NOTES

The following is provided as guidance for use of this Naval Facilities Guide Specification (NFGS):

1. The NFGS is in the three-part Section format established by the Construction Specifications Institute and adopted by the Department of the Navy. The specification is in the SPECSINTACT format to accommodate editing the magnetic media edition using the SPECSINTACT Computer System to produce the project specification section.

2. Technical Notes are interspersed in the body of the specification, if they are ten lines or less, and are separated from the text by a line of asterisks above and below the note. Technical Notes more than ten lines or repeated more than three times remain at the end of the specification under the heading "Criteria Notes," with a notation in the text. All Technical Notes and Criteria Note notations immediately precede the text to which they apply. DO NOT PRINT CRITERIA (TECHNICAL) NOTES OR NOTATIONS IN THE FINAL MANUSCRIPT OF THE PROJECT SPECIFICATION SECTION CREATED FROM THIS GUIDE SPECIFICATION. (Notes can be deleted automatically when using SPECSINTACT.)

3. Do not refer to this guide specification in the project specification. Use it as a manuscript to prepare the project specifications. Edit and modify this guide specification to meet project requirements. Where "as shown," "as indicated," "as detailed," or words of similar import are used, include all requirements so designated on the project drawings.

4. Do not include the following parts of this NFGS in the project specification:

    a. Signature Sheet
    b. Table of Contents
    c. Notes or Criteria Notes
    d. Sketches, if any
    e. General Notes
    f. Other supplemental information, if any, attached to this guide specification.

    Use all parts listed above in the editing process but, when working with printed copy, detach them (where possible) as the first step in editing this guide specification for inclusion in a project specification. (All parts listed above are automatically deleted when printing without notes in SPECSINTACT.) If required for the construction contract, sketches and figures shall be placed on the project drawings. Where there are no project drawings, sketches and figures may be included as a part of the project specification, if required.

5. Project title shall be placed in the upper left corner of each page and is limited to 66 character spaces on one line. (Automatically printed when using SPECSINTACT if the project title is entered as the title in the Job Set-Up Screen).

6. Project specification number shall be placed in the upper right corner of each page. (Automatically printed when using SPECSINTACT if the project specification number is entered as the job name in the Job Set-Up Screen.)

7. Project specification section number and page number shall be centered at the bottom of each page of the section created from this guide specification. (Automatically printed when using SPECSINTACT.)

8. Where numbers, symbols, words, phrases, clauses, sentences, or paragraphs in this guide specification are enclosed in brackets, [], a choice or modification must be made; delete inapplicable portion(s) and brackets. Where blank spaces enclosed in brackets occur, insert appropriate data. Delete inapplicable text and, if not using SPECSINTACT, renumber subsequent articles, paragraphs, sub-paragraphs, accordingly. (Renumbering is done automatically during the print process when using SPECSINTACT.)

9. In compliance with CSI format, article 1.1 SUMMARY has been added to the specification. Use of this article is considered optional by CSI. NAVFAC does not use this article. Article 1.1 shall be deleted for a project specification, but must be present in all guide specifications.

10. Article title has been changed to "REFERENCES" and is always numbered 1.2. This article contains no numbered paragraphs or subparagraphs. Each organization's publications are listed beneath the organization name. Revision letters or dates identifying the current edition of the publication appear in the column with the title.

11. The latest issue of the referenced publications shall be used, but only after reviewing the latest issue to ensure that it will satisfy the minimum essential requirements of the project. If the latest issue of a referenced publication does not satisfy project requirements:

    1. Use the issue shown; or
    2. Select and refer to a document which does; or
    3. Incorporate the pertinent requirements from the document into the project specification.

    Inform the Preparing Activity and NAVFACENGCOM if the latest issue of a referenced publication is not compatible with this guide specification.

    Delete those publications not referred to in the text of this section created from this guide specification.

12. The "SUBMITTALS" article in Part 1 of the section includes a coding system on the magnetic media edition. This provides a project "Submittals List" automatically when editing the magnetic media edition utilizing the SPECSINTACT computer programs on appropriate hardware.

The coding system prints two letters and two numbers on the hard copy for each Submittal type (i.e. SD-14 for "Samples"). The letters and number (i.e., SD-14 for "Samples") are Submittal Descriptions defined in Section 01300, "Submittals."

13. Specifications shall not repeat information shown on the drawings. Specifications shall establish the quality of materials and workmanship, methods of installation, equipment functions, and testing required for the project. Drawings shall indicate dimensions of construction, relationship of materials, quantities, and location and capacity of equipment.

14. CAUTION: Coordination of this section with other sections of the project specification and with the drawings is mandatory. If materials or equipment are to be furnished under this section and installed under other sections or are indicated on the drawings, state that fact clearly for each type of material and item of equipment. Review the entire project specification and drawings to ensure that language is included to provide complete and operational systems and equipment.

15. Any changes or revisions to this document, since the date of the original approval for NAVFAC, have been performed by the Guide Specifications Division (Code DS03) located at the Naval Construction Battalion Center at Port Hueneme, California 93043-5000. (Phone: 805 982-6103)

16. Suggestions for improvement of this specification will be welcomed using the "Agency Reponse Form" located in SPECSINTACT under "System Directory" or DD Form 1426. Suggestions should be forwarded to:

Commanding Officer
Naval Construction Battalion Center
Civil Engineer Support Office
Code DS03
Port Hueneme, CA 93043-5000

-- End of General Notes --

BIBLIOGRAPHY

One Hundred Second Congress, H.R. 2840, **"Hearing Before the Subcommittee on Health and the Environment"**, U.S. Government Printing Office, 1991

Lin-Fu, Jane S., **"Children Today"**, U.S. Department of Health, Education and Welfare, Jan-Feb 1979

Health Hazard Evaluation Report, HETA 91-209-2249, **"Seaway Painting Incorporated, Annapolis, Maryland"**, United States Government Printing Office, 1992

One Hundred Second Congress, H.R. 2922, **"House Subcommittee on Select Revenue Measures"**, U.S. Government Printing Office, 1991

One Hundred Second Congress, First Session, **"Hearing Before the Employment and Housing Subcommittee"**, U.S. Government Printing Office, 1991

Trimber, Kenneth A., **"Industrial Lead Paint Removal Handbook"**, KTA-Tator Incorporated, 1990

Naval Facilities Engineering Command, **"Handout on Lead Paint Removal"**, October 1990

U.S. Department of Commerce, **"Lead Paint Abatement Costs"**, U.S. Government Printing Office, 1979

U.S. Department of Commerce, **"Guidelines for Effective Lead Paint Abatement"**, U.S. Government Printing Office, 1980

O'Bright, Alan, **"Paint Removal From Wood Siding"**, Tech Notes: U.S. Department of the Interior, U.S. Government Printing Office, 1986

"Code of Federal Regulations, 29 CFR", Occupational Safety and Health Administration, Part 1910, U.S. Government Printing Office, 1989

Consumer Product Safety Commission, **"Stripping Paint from Wood"**, U.S. Government Printing Office, 1991

Conversation with C.W. Salmon, FDER Air Program Compliance Coordinator, Northwest District, 27 April 1993

Snyder and Bendersky, **"Removal of Lead Based Bridge Paints"**, National Cooperative Highway Research Report 265, Printed in the U.S.A., 1983

Conversation with Art Leskowich, FDER Hazardous Waste Disposal Coordinator, Northwest District, 27 April 1993

Southern Division of Naval Facilities Engineering Command, **"Plan of Action and Milestones on Exterior Re-Siding and Painting of Flag Quarters"**, 1991

Conversation with Doug Chastang of Naval Public Works Center, Pensacola, Florida, 29 May 1993

U.S. Department of Commerce, **"Lead Paint Abatement Costs: Some Technical and Theoretical Considerations"**, U.S. Government Printing Office, 1979

Chute and Mostaghim, **"Protecting Workers From Lead: A Review of Regulations and Practices"**, Journal of Protective Coatings and Linings, April 1991

"Code of Federal Regulations, 40 CFR", Environmental Protection Agency, Parts 260-290, U.S. Government Printing Office, 1989

Naval Facilities Engineering Command, **"Guide Specification, Removal and Disposal of Lead Contaminated Paint"**, U.S. Government Printing Office, 1992

National Institute for Occupational Safety and Health, **"Criteria for a Recommended Standard, Welding, Brazing and Thermal Cutting"**, Springfield Virginia, 1990

144-403

DEMCO

AMERICAN BINDERY
10
9-93

DUDLEY KNOX LIBRARY
3 2768 00032219 2